TALL CHIMNEY CONSTRUCTION.*—III.

WROUGHT-IRON CHIMNEY.—MESSRS. SCHNEIDER'S CREUSOT WORKS.

	feet	inches
Height above ground	279	0
Diameter at the top	7	6½
" " base	22	11½

Weight, 80 tons.

Its dimensions, therefore, obviously precluded its being raised in a single piece without the employment of appliances which were considered inadmissible; under these circumstances, it was decided to erect the chimney in parts, without the use of any fixed scaffolding whatever.

The chimney, of which we have already given the principal dimensions, is founded on a mass of masonry rising about three feet three inches above the level of the ground, and weighing about three hundred tons; the base of the structure—which is spread—being fixed to this masonry by a very strong angle-iron ring riveted to the chimney-plates, and secured to the foundation by holding-down bolts.

The chimney, properly so called, is composed of rings four feet one inch in height, the plates varying from 0.552 inches thick at the base, to 0.275 inches thick at the summit. At the ninth ring the circumference is made up of eight plates, while at the upper part the rings are each composed of four plates only. To protect the plates from the heat arising from the combustion of the gas, and to prevent the lower rings from being injured, an inner shaft of fire-brick is carried up within the iron casing for the height of eight rings.

CHIMNEY-STACK AT THE WEST CUMBERLAND HEMATITE IRON WORKS.

Engineer, the late Professor Macquorn Rankine.

This chimney represents nothing new in design or construction, and is not of any extraordinary size or figure; but as it is a successful example of the application of correct principles and good workmanship to a structure of a useful and ordinary kind, the publication of an account of it may prove serviceable.

Duty.—The duty which this chimney has to perform is to carry off the gaseous products of combustion from four blast-furnaces, and from various stoves and boilers that are heated partly by burning the inflammable gas from the blast-furnaces, and partly by coal. The total quantity of solid fuel consumed may be estimated at about ten and one-quarter tons per hour when all the furnaces were at work.

Figure and Dimensions.—Above ground the chimney is a frustum of a cone with a straight batter. Underground there is a plinth or basement, octagonal outside at the ground line and square at the bottom; cylindrical inside and pierced with four circular openings for flues. The reason for adopting a straight batter, notwithstanding that a curved batter enables certain theoretical conditions to be more perfectly fulfilled, is that the accuracy of building with a straight batter can be tested at any moment by a glance of the eye without the aid of instruments. The principal dimensions are as follows:—Height above the ground line, two hundred and fifty feet; depth of foundation below the ground line (including a layer of concrete three feet deep), seventeen feet; total height from foundation to top, two hundred and sixty-seven feet. Inside diameter at top of cone, thirteen feet, inside diameter at two feet above bottom of cone twenty-one feet, ten inches; inside diameter in basement, eighteen feet, ten inches; inside diameter of archways for flues, seven feet, six inches; outside diameter at top of cone, fifteen feet, three inches, outside diameter at two feet above bottom of cone, twenty-five feet, seven inches; outside dimensions of square basement, thirty feet by thirty feet; outside dimensions of foundation course, thirty-one feet, six inches by thirty one feet, six inches; outside dimensions of concrete foundations thirty-four feet six inches by thirty-four feet, six inches. The change from the square to the octagonal shape in the basement is made gradually by stepping the brickwork at the corners.

Thickness of Brickwork, Stability and Load.—It had previously been ascertained by observation of the success and failure of actual chimneys, and especially of those which respectively stood and fell during the violent storms of 1856, that in order that a round chimney in this country may be sufficiently stable, its weight should be such that a pressure of wind of about fifty-five pounds per square foot of a plane surface directly facing the wind, or twenty-seven and one-half pounds per square foot of the plane projection of a cylindrical surface—that is to say, a pressure equivalent to the weight of a layer of brickwork three inches deep, and of an area equal to the vertical section of a round chimney—shall not cause the resultant pressure at any bed-joint to deviate from the axis of the chimney by more than one-quarter of the outside diameter at that joint.[2]

By calculating according to that principle, the thickness of brickwork in the cone was determined to be as follows: Uppermost eighty feet of height, one and one-half bricks; next eighty feet of height, two bricks; next eighty-eight feet of height, two and one-half bricks; lowest two feet of height, increasing by steps from two and one-half bricks to four bricks, in order to spread the pressure on the basement.

The bed-joint of least stability is two feet above the ground line, and the deviation of the resultant pressure from the axis of the chimney at that joint, which would be produced by such a wind as has been mentioned, is six feet four inches, being a fraction of an inch less than one-quarter of the outside diameter. The thickness of the arching in the openings for flues is three bricks. The following are the intensities of the mean pressures due to the load on different bed-joints: At two feet above the ground line eight tons on the square foot; in basement at the springing of the arches three tons on the square foot; on the upper surface of the concrete two tons on the square foot; on the ground below one and six-tenths tons on the square foot.

Fire-brick Lining.—The thickness of brickwork already stated, includes the fire-brick lining, whose thicknesses are as follows: In the uppermost one hundred and sixty feet of the cone, one-half brick; in the lower part of the cone, the basement and the flue archways, one brick. The fire-brick lining is bonded with the common brickwork in the ordinary way, the only difference being that the fire-bricks are laid in fire-clay, and the common bricks in mortar. The reasons for adopting this mode of construction in preference to an internal fire-brick chimney are as follows: First, when the fire-bricks are bonded with the common bricks they contribute along with the common bricks to the stability of the chimney, (Mr. Edwin Nash, F.R.I.B.A., says the fire-brick lining must never be considered as part of the structure), whereas, if an internal fire-brick chimney had been used, an additional thickness of common brick-work would have been required in order to give sufficient stability to the outer cone; secondly, unless the internal chimney is carried up to the top of the outer cone there is a risk of damage through the explosion of inflammable gaseous mixtures in the space between; and thirdly, under the same circumstances, there is also a risk of the cracking of the outer cone at and near the upper end of the inner cone through unequal heating at that place. Vertical cracks in a chimney are the more dangerous the higher the level at which they occur, because the safety of the higher part of a chimney depends more on cohesion and less on weight, than that of the lower parts. When such cracks take place near the ground they are of little or no consequence. The basement is paved inside with six inches of fire-brick resting on six inches of common brick which rests on the concrete.

Ordinary Brickwork.—The ordinary brickwork is built of white bricks of very good quality, supplied by the Iron Company. It is built in English bond. In the basement there is one course of headers to every two courses of stretchers, in the cone one course of headers to every three courses of stretchers.

Mr. Clegg, in his "*Manufacture of Coal-Gas*" (J. Weale, 1859), page 176, says: "At the distance of about every fifteen feet, a wrought-iron hoop two and one-half inches by one-half inch thick must be built into the brickwork as the chimney rises; this is necessary to avoid cracks."

Strips of No. 15 hoop-iron, tarred and sanded, are laid in the bed joints of the cone at intervals of four feet in height, with their ends turned down into the side-joints. Care was taken to bed the hoop-iron on the common brickwork, and not on the fire-brick lining. The length of hoop-iron in each bed joint in which it is laid is twice the circumference of the chimney.

Mortar.—In the concrete foundation, the basement, and a small part of the cone the mortar was made of hydraulic lime. Owing to an unexpected difficulty in obtaining such lime on the spot, it had to be brought from a distance at considerable expense, and therefore the mortar for the rest of the building was made of a very pure lime from the immediate neighborhood, rendered artificially hydraulic by a mixture of iron scale from the rolling-mills at the works, it having been in the first place ascertained that the supply of iron scale could be furnished to the contractor with sufficient rapidity.

The following are approximately the proportion of the ingredients of the mortar by measure:—Lime, two measures; scale, one measure; sand, five measures; total, eight measures. It is scarcely necessary to state that the use of iron scale for hardening mortar and making it artificially hydraulic is familiar to engineers, architects and builders in Glasgow and its neighborhood; but in many other parts of the country that process appears to be less known than it deserves. The principal constituents of the iron scale are probably silica and protoxide of iron; but its action upon lime, and the nature of the artificial cement which it forms, have not hitherto, so far as I know, been investigated by chemists. Considering the benefits that have arisen from the chemical analysis of other cementing materials, it is much to be wished that some chemists should undertake the examination of this material also.

Cast-Iron Curb.—Lightning Conductor.—On the top of the chimney is a pitch-coated cast-iron curb, one inch thick, coming down three inches on the outside and inside. The lightning conductor is a copper wire three-fourths inch in diameter. It terminates in a covered drain, in which there is always a sufficient run of water.

Scaffolding.—In the construction of the internal scaffolding care was taken that the needles or horizontal beams should be supported wholly by the brickwork, and not by the upright posts, for great danger has been known to arise from the brickwork coming to bear upon the ends of the needles, and through them, on the posts, owing to the settlement of the lower part of the chimney.

Precautions against too Rapid Building.—In order that the concrete foundation might have time to harden before being subjected to a heavy load, it was made by the Iron Company themselves before the contract for the chimney was let; for it is known that intense pressure tends to retard the hardening of concrete. The progress of the building was restricted by the specification to a rate not exceeding six feet of vertical height per day.

Contract and Execution.—Tenders were taken from a limited number of builders in the North of England and in Scotland, and the lowest offer was accepted, being that of Messrs. William Wilson and Son, of Glasgow. The work was executed by that firm in a manner that left nothing to be desired.

Cost.—The following were the amounts of the estimated and actual cost respectively:—Engineer's approximate estimate, £1,672; actual cost including designing and superintendence, £1,560; being at the rate of almost exactly 4*d.* per cubic foot of the whole space occupied by the building, which is 94,000 cubic feet nearly.

Present Temperature and Draught.—According to the last account, the temperature inside the chimney when doing about three-fourths of its full duty is 490° Fahrenheit, and the pressure of the draught is one and seven-eighths inches of water, which agrees to a very small fraction with the pressure as deduced theoretically from the temperature and the height of the chimney.

Comparison with some other Chimneys.—The dimensions and stability of the chimney which has just been described are nearly the same with those of the second highest chimney at St. Rollox Chemical Works, built about ten years previously, except that in the older chimney the joint of least stability is one hundred feet above the ground. In the great St. Rollox chimney, four hundred and fifty-five and one-half feet high from foundation to top, the greatest pressure of wind which can safely be borne is almost exactly the same, viz., fifty-five pounds per square foot of a plane surface, or about twenty-seven and one-half pounds per square foot of the plane projection of a cylindrical surface. The bed-joint of least stability is two hundred and ten feet above ground. In the great Port Dundas chimney, four hundred and sixty-eight feet high from foundation to top, the bed-joint of least stability is two hundred feet above the ground, and the greatest safe pressure or wind is sixty-seven pounds per square foot of a plane surface, or thirty-three and one-half pounds per square foot of the plane projection of a cylindrical surface; so that here it may be considered that there is an excess of stability.

* A paper by R. M. Bancroft and F. J. Bancroft, read before the Civil and Mechanical Engineer's Society. Reprinted from "American Architect."

[2] See "*Proceedings of the Philosophical Society of Glasgow*," for 1856, page 14.

CHIMNEY-SHAFT AT WOOLWICH ARSENAL.

	ft.	in.
Concrete foundation.		
Height from foundation to top	230	9
" ground "	223	9

Base above ground line 20 feet square.

The plinth and cornice stand twenty-seven feet high, above which the octagonal shaft commences.

	ft.	in.		ft.	in.	
Shaft	16	9	diameter at bottom by	2	7½	walls
"	6	6	" top "	0	9	"

The brickwork is reduced four and one-half inches at every thirty-one feet, six inches, the topmost length being twenty-six feet.

It is all built in mortar, except the top nine feet, which is bellmouthed, and built in cement, and is finished with a Portland stone cap and blocking, weighing about seventeen tons.

Time occupied in building from laying the first brick to the laying the last stone at top was nineteen weeks.

MESSRS. GOSLING'S NORTHFLEET SHAFT.

	ft.	in.
Height from foundations to top	227	0
" ground "	220	0
Outside diameter at base	30	0
" " ground line	23	0
Inside " "	14	0
Outside " top	11	0

Inside diameter at top nine feet six inches, diameter reduced at four feet seven and one-half inches from top to eight feet, nine inches.

The rate of progress in building was under fifteen feet, or two feet six inches per working day.

Principal part of the bricks were Rutter's paviors, or best picked stocks.

The best Dorking gray stone lime, with the best Thames sand, every few courses being grouted in with Portland cement.

Part of this shaft fell in October, 1873, and was rebuilt and finished by August, 1874. Special precautions were taken in rebuilding that all bricks should be wetted before being laid.

WROUGHT-IRON CHIMMNEY, MESSRS. SCHNEIDER AND COMPANY, CREUSOT WORKS.

	ft.	in.
Height	197	0
Diameter at top	4	3
" " of curved base	6	7

Diameter ten feet, increased at bottom by a carved base.

Weight, forty tons.

The thickness of the sheet-iron is three thirty-seconds of an inch at the top, and seven-sixteenths of an inch at the bottom.

It has an inside ladder—was riveted together horizontally, and lifted afterwards with a crane.

WROUGHT-IRON CHIMNEY, PITTSBURGH.

	ft.	in.
Height	196	0
Diameter	6	7

This was riveted together horizontally and then lifted to the perpendicular by a crane.

THE UTOPIAN RAILWAY.—In the House on July, 21st, Sir H. Tyler asked the Secretary of State for War what was the existing condition of the railway from Suakin towards Berber; what length of line had been constructed; whether it was now guarded or maintained, and what portion was still available for traffic, and what quantities of tons of rails and what number of sleepers were purchased or provided; what numbers were dispatched from this country or elsewhere to Suakin; what proportion of those were landed at Suakin, and were still there; what proportion had been sent away from Suakin; to what destination; and where they now were. Mr. W. H. Smith said that no recent report had been received on the condition of this line, but it is known that a portion has been damaged by heavy rains, and it is reported that another portion has been torn up by the Arabs. The total length constructed was 18¾ miles. This is not guarded or maintained beyond the west redoubt, about a mile and a half from the landing place. 15,000 tons of rails and 375,000 sleepers were provided, of which all the rails and 345,000 sleepers were dispatched to Suakin. Of the materials sent out about one-sixth were landed at Suakin and are still there. The remainder were brought back to England, and will probably be made use of at certain military stations where tramways are required.

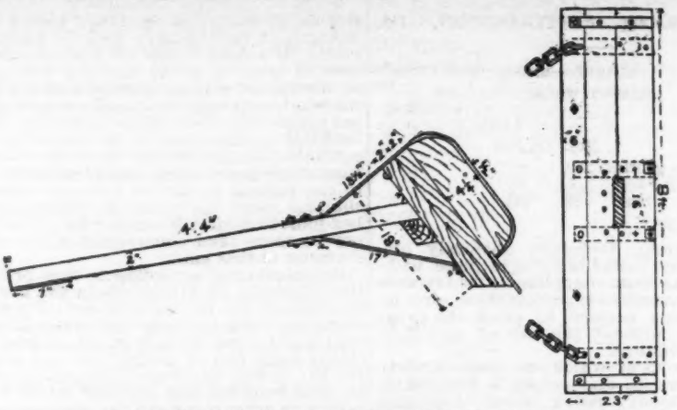


FIG. 1.—"BUCK SCRAPER"—SUTTER COUNTY LAND CO.

Notes on Earthwork.*

BY GEO. J. SPECHT, M. TECH. SOC.

It is not the intention of the writer in presenting this paper, to call attention to any new or startling facts, but simply to note some few points of interest in the ordinary experience of the Civil Engineer. The number of great and novel engineering works is so limited that it is not given to many to have charge and direction of them; but though highly interesting, the lesson they convey is not of as great value to the engineer as that obtained by daily practice in the field. The following notes are therefore submitted to the consideration of the members of this Society.

The Sutter County Land Company owns a tract of land containing 5,000 acres, located in Sutter County, about 16 miles south of Marysville, 8 miles east of the Sacramento river, and 6 miles west of the Feather river. It occupies nearly the center of the Sutter basin, which plays a very important part in the drainage of the northern part of the State, serving during periods of flood as a relief basin to the Sacramento and Feather rivers, whose waters, owing to the insufficient capacity of the river channels, are backed up from the lower end of the basin.

Along the west side of Feather river to a point nearly opposite the mouth of Bear river a levee has been built, which was constructed and is maintained by an organized levee district. Below this point there are only short stretches of private levees, which do not offer an effective protection to the land. During the high water season, therefore, the Feather river overflows its banks above Nicolaus, and submerges a large area of Sutter basin. The channel of the Sacramento river from Butte Slough to Knight's Landing is sinuous and narrow, and according to the State Engineer, has not a sufficient capacity to carry off more than half of the water brought down to it in ordinary high water. It relieves itself by overflowing into Butte Slough, a depression in the Sutter basin, running nearly parallel with the Sacramento river, and submerges the Sutter basin, already partly filled by the overflow of the Feather river, thereby increasing the height of the water and the area overflowed. In the absence of any officially prescribed systems of levees, every land owner constructs his own embankments without considering what their effect may be upon the drainage of the whole valley.

The levees of the Sutter County Land Company, whose property is the vanguard of the entire valley, being located the farthest to the south, will protect a much larger area of land than is embraced in the company's tract; but though these, which are to resist the heaviest attacks, must be higher and stronger than those of adjoining land owners, the company has received but little or no assistance towards their construction. As these levees are not exposed to the constant wash of a river current, their only service is to protect the land against the water flowing into the Sutter basin at periods of flood, when the basin forms a large inland lake. During the winter months, the prevailing south and southeast winds cause waves, which are very destructive to the levees.

The levees built in this section of the country are constructed usually with an outside slope of 3:1 or 4:1, and an inner slope of 1.5 :1 or 2:1, and a top width of from 6 to 10 feet. The earth which is used to form the embankment is taken from both sides of the levee, and is put in place by means of scrapers.

The Sutter County Land Company's levee, as built at present, is 6′ wide on top, with slopes of 3:1 on the inside, and 4:1 on the outside; its height varies from 6 feet to 14.5′. This type will probably be changed gradually to a 10′ wide crest, with slopes 6:1 outside, and 2:1 inside. Bermuda grass will be planted on the slopes to protect them from washing, and a double row of willows will be set on the outside of the borrow pits.

In 1884, work was commenced on August 19th; but it was interrupted December 16th by a heavy rainfall, and consequent overflow, the levee not being completed. Shortly after this storm the entire Sutter basin was overflowed.

In the construction of the levee just referred to, buck-scrapers and a few dump-scrapers were used. The buck-scrapers were 8′ long and 23″ wide from outside to outside. The other dimensions can be seen in Fig. No. 1. Four horses are required to move one scraper. The driver stands on the end of the tail-board, pressing by his weight the edge of the scraper upon and into the ground. This weight was not properly applied in the scrapers used, and two additional men were required to weight them down during the time of filling. The horses pulling ahead, earth accumulates in front of the scraper, and it is moved and deposited where required. To dump the earth, the driver steps off the tail-board and the forward pull of the horses turns the scraper on its lower edge and empties it. The scraper then runs on its side-boards over the deposited earth to the other side of the levee and into the borrow-pit. The side-boards are protected by flat iron, ½″ thick. In the pit the driver takes hold of the tail-board, presses it down upon the ground and steps upon it, and again proceeds as above described.

A certain number of scrapers, varying according to the requirements, were worked in one gang, continuously moving from one side of the levee to the other, an operation by which the earth is well packed. The first load is taken near the foot of the slope, and the circuit enlarged with each trip until that particular section of the pit is scraped clean. In order that the work may proceed without interruption, it is absolutely necessary to have sufficient ground plowed ahead of the scraper gangs.

*Read May 1, 1885, before the Technical Society of the Pacific Coast.

The average height of the levee is 12 feet; the average width of its base 90′; the borrow pits are about 100′ wide each. Subsequently, when the levee became higher, the ground was not plowed for the entire width of the pit, but only about 70′ wide, which gave sufficient earth with a shorter haul. The soil on which the levee was to be built was plowed before any earth was dumped upon it, so that the natural ground and the levee would be properly consolidated. A levee partly finished in 1883, was also plowed before new earth was put upon it. It is necessary to observe this precaution, for when last highwater overflowed all the levees in that neighborhood and washed a considerable quantity of earth from their slopes and crest, those where the surface of the old work of the previous year had been plowed before new earth was put on, settled very evenly, and form now a solid base for the work that remains to be done, while in the levees where the original surface had not been plowed, the newly added earth has been washed down entirely, and the old slope is exposed again.

The levees were built in successive layers of about equal depth. In this way the earth was well packed down by the teams moving over it. As the working capacity of a team rapidly decreases with the increase of the slope, it is advisable to move as much earth as possible upon gentle slopes, which is accomplished in the method adopted. About 90 per cent. of the whole amount of earth was moved on a slope of less than 4:1.

During the construction of these levees the question of the proportions between the bulk of earth in cut and in fill was investigated. The measurements show in all cases an increase in bulk, that is, taking the cross-sections of the borrow pits and of the levee *simultaneously*, the levee showed a larger area than the two borrow pits together. The proportion varied in different kinds of earth. This question must not be confounded with that of final settlement, which sometimes even continues for a long time after the embankment is finished, and must be provided for in the construction by increasing the embankment beyond the limit of the final cross-section desired. There are many causes which influence this settlement, such as the character of the soil of which the embankment is composed, and upon which it is built; the weather during the progress of the work; the mode of construction; the height of the embankment, etc. For each particular case, a separate co-efficient of permanent settlement must be established, varying from 2% to 12% of the height. The rule of the St. Gothard Railroad, in Switzerland, was to increase the height in earth embankment by $\frac{1}{10}$ of its final elevation and in rock embankment by $\frac{1}{15}$. The width of earth embankments was increased on both sides by $\frac{1}{18}$ of the height of the embankment.

As the increase in bulk of earth is liable to lead to disputes, it is best to base contracts on measurements in cut or pit, and to stipulate certain proportions for cases where the necessity require the measurement to be made in fill, and to fix the time when it shall be made. The Austrian North Western Railroad, the construction of which is acknowledged to be above criticism, adopted the rule "that if it should be necessary to measure the material in a fill instead of in a cut, as usual, the amounts in fill must be reduced by 30% in rock, and by 10% in all other kind of soil."

The Imperial Railroad Department of Austria has this clause in its contracts; "If the necessity arises to measure earth and rock in fills, made from material taken from the adjoining cuts or borrow pits, instead of in cut, the cubic contents of the fill must be reduced 30% in rock and 20% in embankments made of earth in layers."

In making the final estimates of the St. Gothard Railroad, the quantities in cut were increased by 3% in earth and 8% in rock, to equalize the amounts needed for embankments.

In the levee work, under the direction of the writer, the following proportions were observed:

9,398 cubic yards in cut gave 9,470 in fill (ground: heavy adobe, measured three weeks after finished).

10,000 cubic yards in cut gave 10,290 in fill (ground: adobe and sandy loam).

29,000 cubic yards in cut gave 30,330 in fill (ground: the same as last).

53,350 cubic yards in cut gave 58,350 in fill (ground: sandy loam with small amounts of adobe and hard pan; this is the largest increase found).

202,634 cubic yards in cut gave 208,915 in fill (this represents the work of three months).

The final conclusion of the writer is, that no general co-efficient can be established to express the proportion of earth or rock in place to earth or rock in fill. It is different with different kinds of material and with the different methods of building the embankments.

A. Von Kaven, President of the Royal Polytechnic Institute in Aix-la-Chapelle, says in his book on "road building":

"The volume of an embankment and its height are different at different times. European experience in road building is that, after the fill is finished, the earth used therein occupies a larger space than in the ground:

In clay and loam	1-48 more.
In soft sandstone	1-32 "
In hard clay	1-20 "
In rock	1-13 to 1-10 "

"During the construction of the Rhine-Nahe Railroad, it was observed that the increase in bulk from cut to fill was in the beginning 25 per cent. in rock, but when from one quarter to one third of the total bulk of the embankment was built of clay, put in simultaneously with the rock, the final increase in embankment, after the same was finished, was only 9 per cent. There are certain kinds of earth and certain conditions during the time of building, when the embankment occupies less space than the earth measured in place. For instance, if the earth is wet, or if it is tamped, etc. The French engineer, Graeff, says that 1 cubic meter of rock measured 1.5 to 1.6 whenever in fill, but as considerable earth was used with it to fill the intermediate spaces, 1 cubic meter cut made 1 cubic meter fill in a general average."

"In building the Marne-Rhine canal the loose earth was carefully tamped and 1 cubic metre embankment required 1.10 to 1.25 cubic metre in cut. He advises, therefore, not to count on any difference, but to accept cut and fill alike, and allow only in very light sand a decrease of one-tenth in fill.

"According to a series of observations—

"100 cubic feet of loose sand make 115-120 cubic feet in fill.

"100 cubic feet of clay and coarse sand make 122 cubic feet in fill.

"100 cubic feet of hard clay, lias, make 124 cubic feet in fill.

"100 cubic feet of clay mixed with cobblestones make 126 cubic feet in fill.

"100 cubic feet of decomposed rock, solid gravel banks, make 128 cubic feet in fill.

"100 cubic feet of rock (can be picked) make 130 cubic feet in fill.

"100 cubic feet of rock, requiring blasting, make 134-150 cubic feet in fill."

Henz, the author of a Manual on Earthwork, states as the result of a large number of observations of actual work, that the permanent increase in volume from cut to fill is—

In sandy soil	1-1.5 per cent.
In clay and light soil	3 "
In marl	4-5 "
In hard clay	6-7 "
In rock	8-12 "

J. C. Trautwine in his pocket-book, says on page 630, edition of 1876: "Although earth when first dug and loosely thrown out, swells about ¼ part, so that a cubic yard in place averages about 1¼ or 1.2 cubic yards when dug; or 1 cubic yard when dug is equal to ⅘ or 0.8333 of a cubic yard in place; yet when made into embankment it *gradually* subsides, settles or shrinks into a less bulk than it occupied before being dug."

This refers undoubtedly to the permanent settlement for which proper allowance in the building of embankments, by increasing their dimensions, must be made.

The capacity of one buck-scraper during the construction of the Sutter County Land Company's levee was as follows:

70,000 cubic yards were moved in 1,277 scraper-days, or one scraper moved per day about 55 cubic yards.

294,000 cubic yards were moved in 3,249 scraper-days, or one scraper moved per day 90.5 cubic yards.

The small capacity in the first case was due to the inexperience of the contractor as well as of the teamsters, and to the fact that it was an old levee, partly finished the year before, which necessitated a higher pull.

The total work done was 364,000 cubic yards, moved in 4,526 days, or 1 scraper moved per day 89.5 cubic yards in an average.

In the cost of the work, the sums given in reference to feeding of horses and boarding of men are not quite authoritative, but the usual prices charged by livery stables and farmers have been used.

In October were 22 working days. The expenses were

Hire of horses, 272 horses @ 30 cents per day	$2,992.00
Wages of men	3,750.00
Feeding of horses @ 35 cts. per day, 31 days	2,940.00
Boarding of men	1,488.00
	$11,170.00
Number of cubic yards moved	116,000
Cost of one cubic yard	9.63 cents.

In November were 25 working days. The expenses were:

Hire of horses, 310 horses @ $0.50	$1,875.00
Wages of men	3,996.00
Feeding of horses (20 days)	3,255.00
Boarding of men	1,440.00
	$12,566.00
Number of cubic yards removed	110,000
Cost of one cubic yard	11.4 cents.

This shows the rapid increase of cost with the increase of height of levee.

The contract price was 12 cents per cubic yard, measured in the borrow pit.

The levees were not completed, as the heavy rains in December caused the overflow of the entire Sutter basin.

Fig. No. 2 shows the cross section of the levee before and after the high water.

Fig. No. 3 shows the cross section of another levee of the same reclamation, before and after the last high water.

The latter was built with an outside slope of nearly 6:1; the same was not washed by the waves to any extent, while its 3:1 inside slope was badly damaged by waves, which proves that any slope steeper than 6:1 should not be used in these levees.

A break occurred in another levee, principally caused by bad location, forming a sharp prominent corner. Such prominent corners and turns should be avoided by all means. In connecting two levees of different directions with each other, flat curves should be used, even at a sacrifice of arable land, and the levee should be strengthened by a flatter outer slope, greater top width and higher elevation. This break was repaired by Chinese labor and wheelbarrows. Seven wheelbarrow loads made one cubic yard. Average haul, 208′; vertical raise 7′ ground; moist adobe, requiring frequent cleaning of shovel and barrow. Average time of one round trip was 7½ minutes; time required to move 1 cubic yard, 52½ minutes (counting from the moment when shoveling in the pit commenced to the same time after a complete round trip.) Average work of one wheelbarrow per 9½ actual working hours, 10.8 cubic yards. The cost was as follows:

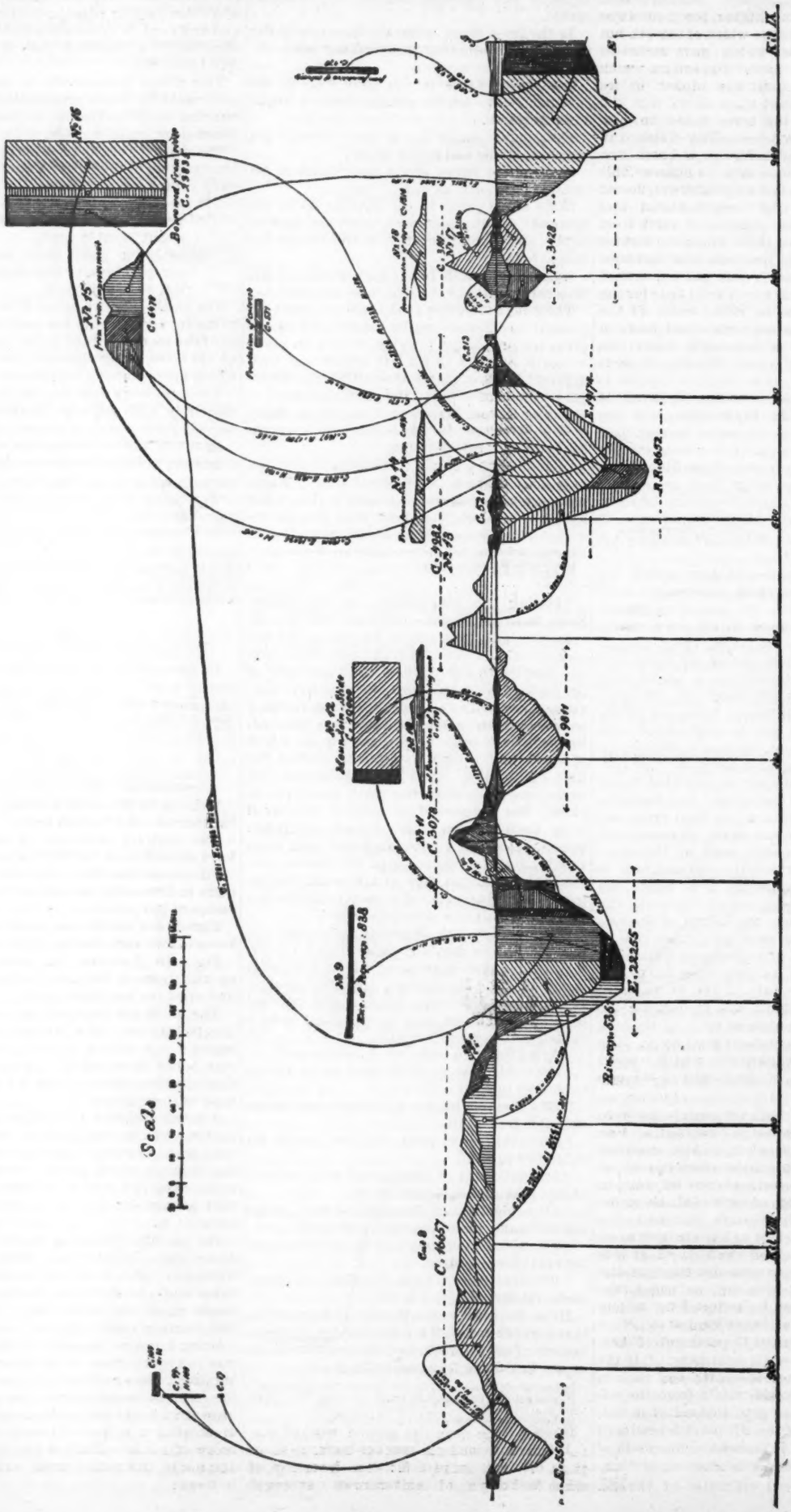


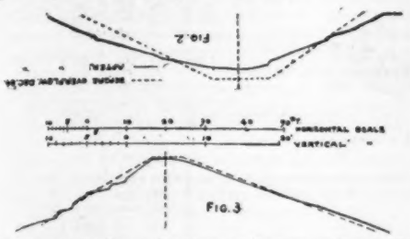
FIG. 7.—DISTRIBUTION PROFILE; GENERALLY USED IN EUROPE IN MAKING PRELIMINARY ESTIMATE OF QUANTITIES UPON WHICH TO INVITE PROPOSALS FOR RAILROAD WORK.

13 Chinese @ $1.50	$19.50
1 white foreman and his board	2.50
	$22.00

Work per day, 10 wheelbarrows, 108 cubic yards, hence cost of one cubic yard, 20.3 cents.

In these expenses, as well as in the above ones given, nothing has been allowed for wear and tear, and no percentage added for the cost of the plant.

Several years ago the writer was connected with the construction of the Upper San Joaquin Irrigating Canal in Fresno County. The canal runs for several miles along a high bluff, which is apparently the shore of the old river channel. This bluff, which is composed of sediment, sand and hard pan, 2:1 to 1.5:1 for about 75 per cent. of its length. There is no rock, and the hard pan occurs in strata of from a few inches to one foot in thickness, separated by quicksand. The hard pan is sufficiently solid to stand with a slope of 0.5:1, while the underlying sand rests only at 2:1 or 3:1. This necessitated flatter slopes than the hard pan above required. Where the hard pan cropped out, it was very hard, while at some depth below the surface, it could be picked, and still deeper be plowed.



FIGS. 2 AND 3.—CROSS-SECTIONS OF LEVEES IN SUTTER CO

Figures 4 and 5 show two characteristic cross-sections of this canal. The work of excavation and of building lateral embankments was done by buck scrapers and dump scrapers The dimensions of the first can be seen in Figure 6.

As all the loads had to be moved down hill, the work performed daily by one scraper was

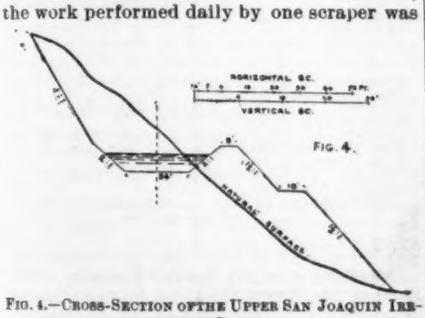


FIG. 4.—CROSS-SECTION OFTHE UPPER SAN JOAQUIN IRRIGATION CANAL.

large. Observations showed that, with a total length of the round trip of 400' and a vertical distance of 40', in 9 actual working hours one scraper made 95 round trips, carrying at each 1.3 cubic yards. All the conditions were very favorable. This is the average of 1000 observations. The maximum load observed was 1.64 cubic yards. Later observations of the same piece of work showed an average daily capacity of one scraper of 128 cubic yards.

The dump scraper moved on an average 5 cubic feet per load. They were used principally to move the earth to the edge of the canal, whence it was taken by the buck scrapers In a round trip of 225 feet length, one dump scraper moved 18 cubic yards per 9 hours actual work. Ground was very favorable.

The cost of this work was as follows:
Month of November, 1882:

Daily expense of one buck scraper:

4 horses, hire @ 37½ cents	$1.50
4 " feed @ 40 cents	1.60
1 driver, wages (1.15) and board (40 cents	1.55
	$4.65

Daily expenses for one dump-scraper:

2 horses, hire, @ 37½ cents	$0.75
2 horses, feed, @ 40 cents	0.80
1 driver, wages and board	1.55
	$3.10

Daily expenses for one six-horse plow:

6 horses, hire and feed	$4.65
2 men, wages and board	3.10
	$7.75

Daily expenses for one four-horse plow:

4 horses, hire and feed	$3.10
2 men, wages and board	3.10
	$6.20

General expenses for November:

1 foreman	$70.00
½ bookkeeper ($70)—attending to two camps	35.00
1 blacksmith, @ $3	78.00
1 hostler	30.00
2 Chinese cooks	60.00
Board for these men	66.00
Feed for four work horses	48.00
	$387,00

for 30 days or $12.90 per day.

In this period of 27½ days were moved 55,925 cubic yards. This required—

29.5 six-horse plows, @ $7.75	$228.63
15.5 four horse plows, @ $6.20	96.10
409 buck-scrapers, @ $1.65	1,901,85
130.5 dump-scrapers, @ $3.10	404.55
33 men on dump, @ $1.55	51.15
328 Chinese, @ $1.15	377.30
18 Chinese bosses, @ $1.75	31.50
	$3,090.98
General expenses during the same period (October 30th November 30th)	406.35
Cost of moving 55,925 cubic yards	$3,497.33

or cost of one cubic yard, 6.25 cents. The contract price for this work was 9 cents.

Month of January, 1883. January 8th to 31st.

301 buck-scrapers, @ $5	$1,505.00
86.5 dump-scrapers, @ $3.30	285.45
62.5 six-horse plows, @ $8.25	515.63
2 four-horse plows, @ $6.60	$13.20
2 V scrapers, @ $1.155 (8 horses, 4 men)	23,10
522 Chinamen, @ $1.15	600.30
52 white laborers, @ $1.65	85.80
22 days' general expenses, @ $14.55	320.10
For emergencies	51.42
Total	$3,400.00

The increase in the prices is due to a closer analysis of the cost of feeding the horses and to the addition of one hostler.

During that period 42,241 cubic yards were moved; therefore the cost of one cubic yard was 8.04 cents.

The average capacity of one scraper per day was 131 cubic yards. A large portion of the excavated earth had to be moved several times, as the canal was in a thorough cut on a high bluff (Fig. 5). The moving was done by buck-and-dump-scrapers to the edge of the bluff, and then pushed over the latter by plows and a V-scraper.

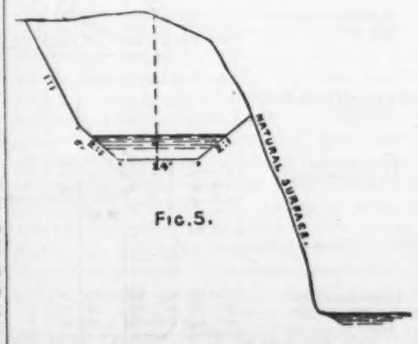


FIG. 5.—UPPER SAN JOAQUIN IRRIGATION CANAL.

The cost of one cubic yard during the first five days of January was 7.24 cents.

During these days the ground worked was on a side hill with an average natural slope of 2.5:1; the longest distance from top of slope to bottom of embankment averaged about 100'; very little hardpan was met during this period, but afterwards a large amount was struck, which accounts for the increase in price above mentioned

During February, 1883, 80,000 cubic yards were moved at a total cost of $8,684 or price of one cubic yard, 10.8 cents; this included $1,000 for Judson powder.

In reference to plowing we have the following items; Observations of January: 1 eight-horse plow kept 12 buck-scrapers busy; the price for plowing the ground, reduced to the cubic yard moved, was 0.70 cents per cubic yard. In another section the cost was 0.58 each.

Observations in February: 1 eight-horse plow and 1 six-horse plow were needed to keep 17 buck scrapers employed in a length of 1,500' of canal. These 17 scrapers moved 2,210 cubic yards, the loosening of which represents the work of the two plows. The soil was loose sand, and only about for a length of 200 feet hardpan. The expense for plowing was $18.25, or 0.83 cents per cubic yard. Later in February more hardpan was encountered and the cost of plowing increased to 1.05 cents per cubic yard, and later on yet to 1.25 cents.

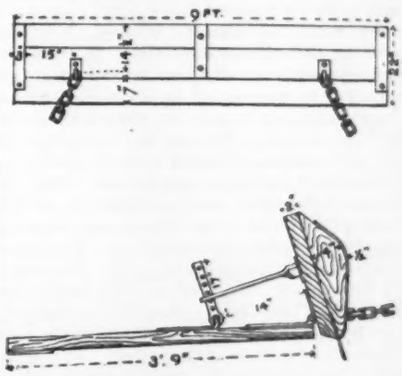


FIG. 6.—" BUCK SCRAPER," UPPER SAN JOAQUIN IRRIGATION CANAL.

In connection with the question of earthwork, a method may be mentioned which is in general use in Europe, though it is not known here apparently. In making estimates for railroads and inviting bids for c ntracts, the Europoan custom is, that the railroad company makes a very detailed estimate; and the result of this—in detail, as well as in general—is made the base for the contractor's bid. In the call for bids, the cost estimated by the company is given, and contractors are invited to bid so many per cent. below or above it. This method requires a very carefully made estimate, based on detailed studies of the ground, assisted by trial-pits; very often, especially in tunnel-work and foundations, extensive trials are made. The results of all these studies are at the disposal of the contractors; they comprise a longitudinal profile, a complete set of cross-sections, adistribution-profile, detail plans of all the bridges, culverts, road-crossings, retaining walls, etc.; a map of the railroad, list of prices for labor and material, as ascertained by the company; in fact all papers and documents necessary for an intelligent bid.

Among the documents mentioned above, is one called "Distribution of Masses," or "Distribution-Profile." This is a graphical representation of how to dispose of the material gained in cuts and how to make embankments. The method is as follows:

Draw a horizontal line, dividing the paper into two equal parts, and representing a dividing line between cut and fill; mark upon this line the distances where the cross-sections have been taken and erect perpendicular lines in these points, for cuts above and for fills below the line. Mark upon these lines the areas of the respective cross section, according to a certain scale—say one square metre equa

to five millimetres—connect the ends of these perpendiculars by straight lines. Then the areas so formed represent the cubic contents of each cut and fill. The value of these areas are determined by planimeter. The excavation of the foundations of bridges, culverts, slope-ditches, etc., and the amounts needed for road-crossings, or similar purposes are also determined and platted in the distribution profile at their proper places. Then the distribution of the earthwork is made, which is best explained by an actual example. The Figure, 7, represents a section of 1800 m. (5904') length.

The cuts, excavation for foundations and borrow-pits are numbered successively from division 8 to division 19. The fills are not numbered. The dotted lines show the lines of separation between loose ground and solid rock. The excavation of cut No 8 has to serve to make the fills adjoining it above and below. The fill above requires 5,504 cubic meters; a part of this will be made by earth gained in the cross-sections themselves by lateral transportation, another part by the material gained from the foundations of culverts and from the correction of the water-courses, the remainder will be taken from cut No. 8.

The remaining material of cut No. 8 is then used for the embankment above it. The foot of the latter being exposed to the river current, has to be secured by rip-rap, therefore the rock gained in the cut must be reserved for that purpose. The cut No. 8 contains 16,657 cubic meters, of which 8,573 are loose material and 8,084 cubic meters rock. Then the length of the haul was determined by establishing the center of gravity of each area and scaling the distance between these. The center of gravity of irregular areas was determined by cutting the areas out of card-board, then suspending them from one of the corners on a fine needle, placed in a perpendicular line, drawn on the wall of the office. The point where the opposite side was intersected by this perpendicular line was marked upon the card-board and connected with the needle point; this operation was repeated for another side. The point of intersection of the two lines gives the center of gravity of that area. The points so ascertained were then transferred to the distribution profile and the distances between them, measured by scale, were adopted as the length of haul.

The embankment between the cuts 8 and 10 cannot be filled entirely from the adjoining cuts, but a part of it has to be filled from a borrow-pit.

This one example is sufficient to explain the method, which is certainly an interesting one, and which, in spite of its seeming complications, is very simple and is of the greatest assistance in estimating the cost of a railroad and in furnishing an intelligent, accurate base for contractors to bid on.

For further explanation, see appendix.

A different system of "distribution-profiles" will be explained in a future paper.

APPENDIX.

Explanation of Fig. No. 7.—The areas above the center line are those of cuts, borrow-pits, excavation of foundations for bridges, culverts, rip-rap, etc. The areas below are those of fills and deposits of surplus earth. The centers of gravity are indicated by small circles, the curved lines connecting them indicate the haul; the figures written along them give the number of cubic meters in cut (C) and in embankment (E), and the length of the haul (H) in meters. $C\{^{E}_{R}$ means cut $\{^{\text{earth}}_{\text{rock.}}$

Where R stands in place of E, it means rip-rap.

The following tables give the items how the excavation of each cut is disposed of, and how each embankment is built. It is customary to write these items on the distributed profile itself; but to make the latter more distinct, they are here written in a separate list.

The words "from cross-sections" in this list mean, that the railroad are partly in cut and partly in fill, and that the earth from the cut is hauled laterally to make the fill in the same cross-section. The entire example is given in metric measure.

The material from excavations is to be used as follows:

No.	Description.	Location. from Stat.	Location. to Stat	Cubic Meters in Place	Length of Haul.	Percentage of Increase.
8	Cut, 7 + 855 to 8 + 175					
	Embankment	8 + 160	8 + 190	1,112	40	3
	Rip-rap	8 + 170	8 + 220	3,308	90	8
	Embankment	8 + 190	8 + 235	2,876	215	8
	"	8 + 190	8 + 235	5,394	215	3
	"	7 + 800	7 + 870	1,900	80	8
	"	7 + 800	7 + 870	2,067	80	3
				16,657		
9	Excavation for Rip-rap, 8 + 170 to 8 + 300.					
	Cross-sections	8 + 170	8 + 300	838	10	3
				838		
10	Excavation for retaining Wall, 8 + 370 to 8 + 495.					
	Embankment	8 + 277	8 + 290	1,778	150	3
				1,778		
11	Cut, 8 + 280 to 8 + 400.					
	Embankment	8 + 300	8 + 320	497	55	3
	Cross sections	8 + 350	8 + 400	500	10	3
	Embankment	8 + 290	8 + 300	431	10	3
	Rip-rap	8 + 270	8 + 300	888	65	8
	"	8 + 220	8 + 250	762	100	8
				3,078		
12	Borrow-pit in Talus of Mountain Stream, 8 + 360 to 8 + 500.					
	Cross sections	8 + 360	8 + 500	9,017	40	3
	Embankment	8 + 270	8 + 277	983	130	3
				1,000		
13	Cut 8 + 470 to 8 + 580.					
	Rip-rap	8 + 580	8 + 645	4,169	90	8
	In cross-sections	.....	.....	813	15	3
				4,982		
14	Excavation for Rip-rap, 8 + 580 to 8 + 600.					
	Embankment	8 + 600	8 + 710	1,691	35	3
				1,691		
15	Excavation from Improvement of Marchlis-bach.					
	Embankment	8 + 850	8 + 890	3,012	110	3
	Rip-rap	8 + 780	8 + 810	1,697	65	3
	"	8 + 625	8 + 645	1,707	120	3
				6,478		
16	Borrowed from Marchlis-bach.					
	For rip-rap	8 + 645	8 + 690	2,258	150	3
	In Embankment	8 + 238	8 + 270	7,561	550	3
	"	8 + 600	8 + 710	14,016	140	3
				23,835		
17	Cut 8 + 776 to 8 + 860.					
	Cross-sections	8 + 785	8 + 850	1,024	10	3
	Embankments	8 + 776	8 + 785	458	18	3
	Rip-rap	8 + 810	8 + 870	1,629	20	3
				3,111		
18	Excavation for Rip-rap, 8 + 780 to 8 + 870.					
	Embankment	8 + 690	8 + 710	1,516	165	3
				1,516		

The embankments have to be filled as follows;

Description.	Location. from Stat.	Location. to Stat.	Cu. Met. in Place	Cu. Met. in Fill.	Length of Haul.	Percentage of Increase.
Embankment, 7+760 to 7+890.						
From cross-sections.	7+760	7+780	142	153	10	8
" " "	7+765	7+820	216	222	10	3
From excavation for culvert and correction of creek	7+800		555	572	15	3
" "	7+877		140	151	10	8
" "	7+877		218	224	10	3
From cut	7+850	7+952	1,900	2,052	80	8
" "	8+850	7+952	2,067	2,130	80	3
				5,504		
Rip-rap, 8+190 to 8+300.						
From cut	8+330	8+350	888	965	55	8
" "	8+310	8+330	762	823	100	8
" "	8+050	8+160	3,308	3,573	90	8
				5,361		
Embankment, 8+160 to 8+320.						
From excavation for rip-rap	8+370	8+495	1,778	1,831	.....	3
From cut	8+120	8+175	1,112	1,145	.....	3
" "	7+950	8+110	5,394	5,556	.....	3
" "	7+950	8+050	2,876	3,106	.....	8
" "	8+275	8+335	431	444	.....	3
" "	8+350	8+3 0	497	512	.....	3
" talus of creek.	8+	400	983	1,012	.....	3
" excavation for rip-rap	8+170	8+300	838	863	.....	3
Borrowed from Marchlis-bach	.....	.....	7,561	7,786	.....	3
				22,255		
Embankment, 8+350 to 8+490.						
From talus of creek	8+360	8+500	9,017	9,296	40	3
" cross-sections	8+355	8+465	500	515	10	3
				9,811		
Rip-rap, 8+580 to 8+690.						
From improvement of Marchlis-bach	.....	.....	1,769	1,822	120	3
From cut	8+470	8+570	4,169	4,502	90	8
Borrowed from Marchlis-bach	.....	.....	2,258	2,328	115	3
				3,428		
Embankment, 8 + 565 to 8 + 750.						
From cross sections	8+720	8+750	213	219	15	3
From excavation for rip-rap	8+780	8+870	1,516	1,561	165	3
From excavation for culvert	.....	.....	571	598	45	3
From cross-sections	8+585	8+650	600	618	15	3
From excavation for rip-rap	8+580	8+690	1,691	1,742	35	3
Borrowed from Marchlis-bach	.....	.....	14,016	14,436	140	3
				19,174		

TEMPERATURE OF THE EARTH'S INTERIOR.—The London *Times* says the German Government is having a deep shaft sunk near Schladebach, with the object especially of obtaining trustworthy data concerning the rate of increase of the earth's temperature towards the interior. At the beginning of this year the shaft had reached the depth of 1392 metres, which is believed to be the lowest yet reached. The temperature at successive stages is ascertained by a special thermometer, the principle of construction being that as the heat increases the mercury will expand so as to flow over the lip of an open tube. The difference of the overflows will give the rate of increase of the temperature. It has been ascertained that the temperature at the depth of 1392 metres was 49 deg. Centigrade, or 120 deg. Fahren. If the temperature increases regularly at this rate, the boiling point of water ought to be reached at a depth of 3000 metres, and at 75 kilometres we should find the heat at which platinum melts. This would go to show that the earth's crust cannot be more than about one-ninetieth of its radius.

THE San Antonio and Aransas Pass R. R. Co., has authorized the issue of $1,750,000 first mortgage bonds. The contract for 10,500,000 feet of lumber has been let to a San Antonio firm.

OUR MATHEMATICAL COLUMN.

THE GROUNDE OF ARTES: Teaching the workes and practices of Arithmetick, bothe in whole numbers and in fractions, after a more easyer and exacter sorte than any like hath hithertoe been sette forthe: Made by M. Robert Recorde, Doctor of Physik, London, 1573, 12 mo.

This rare old book is entirely written in the form of a dialogue between a schoolmaster and his pupil. This style of instruction must have been very popular, for the work printed in 1540 was continually republished in numerous editions until 1699. To give an idea of this standard text-book of our English forefathers, we present a couple of extracts, generally preserving the quaint spelling of the original, but using modern type instead of the old block letter. The book opens with a dialogue on the advantage of learning arithmetic, from which we first quote:

Master.—"If numbering be so common that no man can doe anything alone, and muche lesse talke or bargaine with other, but he shall still have to doe with numbre; this proveth not numbre to be vile and contemptable, but rather right excellent and of high reputation, sithe it is the grounde of all men's affairs, so that without it no tale can be told, no bargaining without it can dully be ended, or no business that man hath, justly completed. These commodities, if there were none other, are sufficient to approve the worthiness of numbre. But there are other innumerable, farre surpassing these, which declare numbre to exceed all praise. Wherefore in all great works are clerks so much desired? Wherefore are auditors so richly feed? What causeth Geometricans so highly to be enhounced. Why are Astronomers so greatly advanced? Because that by numbres such things they find, which else would farre excell man's minde.

Scholar.—Verily, sir, if it be so that these men, by numbering, their cunning do attain, at whose great workes most men do wonder, then I see well I was much deceived, and numbring is a more cunning thing than I take it to be.

Master.—If number were so vyle a thing as you did esteeme it, then need it not to be used so much in men's communication. Exclude Numbre and answer to this question: How many years old are you?

Scholar.—Mum.

Master.—How many daies in a week? How many weekes in a yeare? What lands hath your father? How many men doth he keep? How long is it sithe you came from him to me?

Scholar.—Mum.

Master.—Why, thus you may see, what rule numbre beareth, and that if numbre be lacking, it maketh men dumbe, so that to most questions, they must answer mum."

Having convinced his pupil of the value of the study, the teacher proceeds to teach him numeration, addition subtraction and so on in order. The method of presentation generally is that the master explains and illustrates the process, and then tests the pupil by requiring him to perform an example, the latter all the time asking questions on doubtful points. Thus, in addition, after having explained the idea of carrying, the master gives the scholar 848 and 186 to be added together, saying:

"Now let mee see: how can you add those two summes?

Scholar.—I must first set them so, that the two first figures stand one over the other, and the other each over his fellow of the same place, then shall I draw a line under them both. And so likewise of other figures, setting always the greatest numbre highest' thus as followeth:

848
186

Then must I add 6 to 8, which maketh 14, that is mixt-numbre, therefore must I take the digit, which is 4, and write it under 6 and 8, keeping the article 1 in my mind, thus:

848
186
4

Next that, I doe come to the figures, adding them up together, saying eight and four make twelve, to which I put the one reserve in my mind, and that maketh 13, of which numbre I write the digit 3 under 8 and 4, and keep the article in my minde, thus:

848
186
34

Then I come to the third figures, saying 1 and 8 make 9 and the article in my mind maketh 10. Sir, shall I write the cypher under 1 and 8?

Master.—Yea.

Scholar.—Then of 10 I write the cypher under 1 and 8, and keep the article in mind.

Master.—What needeth that, seeing there followeth no more figures?

Scholar.—Sir, I had forgotten, but I will remember better hereafter. Then seeing I am come to the last figures, I must write cypher under them, and the article in a further place after the cypher, thus:

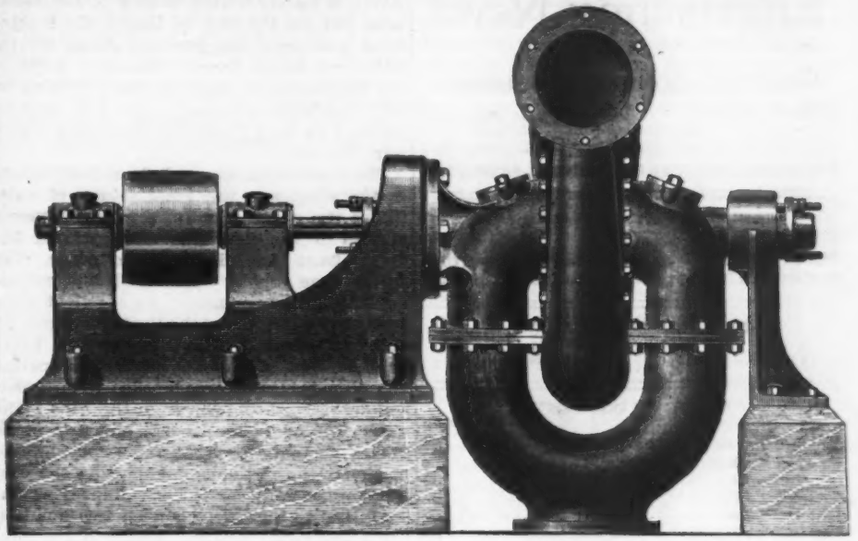
848
186
1034

Master.—So now you see that of 848 and 186 added together, there amounteth 1034.

Scholar.—Now I think I am perfect in addition.

Master.—That I will prove by another example. There are two armies: in the one are there 106,800, and in the other 9,400. How many are there in both armies, say you?"

Robert Recorde was born about the year 1500, and died in 1558, in prison, as commonly stated, for debt. He was a teacher of mathematics at the University of Oxford, and later, physician to Edward VI and Queen Mary, to whom he dedicates some of his books. He was the author of several mathematical works, of which "the Cossike Practice, with the rule of equation," published in 1537, was the most important. This is the earliest book on algebra printed in England, and in it for the first time two parallel lines are used for the sign of equality, because, says he "noe 2 thynges can be moare equalle." According to DeMorgan, Recorde was a remarkable genius, and it must be remembered that he was a lawyer and a physician, as well as the first mathematician of his day.



Contractor's Pumps.

The pump illustrated is made by the Lawrence Machine Co., of Lawrence, Mass. In its design the company has endeavored to meet requirements in pumping engines, thought to be wanting in machines of the same class. The advantages claimed over other centrifugal pumps, is the ability to change the relative positions of the suction and discharge pipes at will, and that the whole pump can be revolved in a vertical plane about its own axis, enabling it to suck or discharge at any desired angle.

These very desirable features of working in a contractor's pump are accomplished as follows: The central volute, (see cut) is a separate casting, and has bolted on to each of its sides a cover plate; one of these covers carries the broad flange next to the driving belt, which flange is bolted to the base casting which supports the whole pump. The center volute is bolted to the inner, or "supporting cover," and the outer cover is bolted to the volute. The bolt holes are all evenly spaced, so that the volute may be turned to any desired angle between the covers, or even revolved entirely about, making the pump a right or left-hand machine at will. The branch suction or "breeches pipe," is now bolted on, and the pump is ready for service. It is, of course, understood that when the pump is changed from right hand to left, the disk must be pulled off from its key and replaced so that the curved blades be in the proper position to do their work.

Again, the entire pump can be revolved at the flange attached to the base casting by simply slacking the flange bolts, which have heads fitting in a T-shaped annular slot in the base casting. This is done without interfering with any of the other parts, or doing anything but slackening the bolts mentioned; the discharge can thus be led in any direction thought best.

The base casting is made very heavy and strong; there are two supporting colums for the driving pulley, and the boxes supporting the shaft are of bronze, in halves, fastened by four bolts each, and have an arrangement for taking up the wear.

The pump has regular stuffing-boxes on each side, with long bearings to support the shaft, and ample room in each stuffing-box to use sufficient packing to effectually prevent air from entering the pump along the shaft, and accomplish this without undue friction. The outer end of the shaft, when in use, is completely enveloped by a cap casting, which prevents its being injured in any way, and also serves as an oil reservoir for the stuffing-box.

These pumps are carefully designed on accurate and accepted principles as regards areas of parts and volume of passing water. They will pump sand and gravel without detriment to the wearing parts of the pumps, all of which are well protected, and, as the covers, volute and pipes are one-third thicker in metal than any other centrifugal pump made in this country, they will resist at least one-third longer the abrasion from sand and gravel.

All pumps are erected and tested by hydraulic pressure and actual pumping trial before leaving the works, and a record kept of their performance. They are made in three classes A, B and C for high, medium, and low lift. A catalogue giving all desirable data can be obtained from their makers, the Lawrence Machine Co., Lawrence, Mass., U. S. A.

ADV.

ARTESIAN WELLS derive their name from the Province of Artois, France, where it was generally, supposed they were first used. They appear however, to have existed in Egypt at a very remote period, and are said to be found in the province of On-Tong-Kiao, China, extending to a depth of 500 to 1800 feet.

The artesian well at Passy, near Paris, is 1913 feet deep and finished with a diameter of 2 feet. The yield is 3,795,000 gallons per day. It took 6¾ years to drill it, and cost $200,000.

ACCORDING to the best figures obtainable, the blast furnaces of the country have over 600,000 tons of pig iron on hand. There are 227 furnaces in blast, the greater part of the furnaces being out of blast.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

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TABLE OF CONTENTS

	PAGE
Tall Chimney Construction	113
Notes on Earthwork (*Illustrated*)	114
Our Mathematical Column	119
Contractor's Pumps (*Illustrated*)	119
Editorial Notes	120
The Lesseps Report on the Panama Canal	120
The "Waterstaat" of Holland	120
The Haag Metropolitan Railway for Paris	121
Personals	121
Lake Michigan Fluctuations	121
Gen. Anderson's Retirement	121
Water and Sewerage as a Preventive of Typhoid	122
Steel Rails	122
The Great Guns of the Day	122
The Fastest Railway Speed	122
Market Street Bridge, Philadelphia	122
Correspondence	123
A Dam Across the Potomac	123
The First Railroad in America	124
Track	124
The History and Statistics of American Water Works	124
Water	125
News of the Week	125
Index to Periodicals	128
Market Report	128

As the demand for steel rails is a pretty fair index of the existing condition of affairs in railroad circles, we are glad to see that the price has advanced within the last week to $28.00 per ton. To use the word "advance" in connection with the low price stated would be rather bitter irony, were it not for the fact that rails sold for $26.50 only two weeks ago.

We learn from *Engineering* of July 31st, that "The First Lord of the Admiralty has stated in the House that he is informed by Sir Geoffrey Hornby that the Ajax, up to the speed at which she has been tried with the Evolutionary Squadron, viz: about 10 knots, is not considered to be an unsafe ship to manœuvre with a squadron."

It would be interesting in connection with the advice often given that we should buy our war ships in England, to know what was thought to have been the matter with the Ajax that she was not safe at "about 10 knots." We fear that the designers of the Ajax must have shown some of the incompetency lately charged to American builders by an English contemporary.

An early English seeker after the simplification of weights and measures, proposes in the *Mechanic's Magazine*, of London, Sept. 1830 what he calls a "decimal account."

The author is very obscure in expressing his proposed reform, but he takes the foot as a basis and divides it into 100 Centifoot, and calls the foot a "linear." A yard is 300 centifoot; and in land measure he uses a "line" equal to 100 feet; a "mille" equalling 1000 feet, and a league as 10,000 feet. He uses 2 cubic feet, or 2000 ounces of distilled water as equal to one "Hundred" pounds of 100 "drams" each, and calls 20 "hundred" a marine ton.

His "system" practically amounts to no system at all, but the attempts are of some interest in the light of the present metric and anti-metric controversy.

In an interview with Mr. J. F. Alden, of the Alden & Lassig Bridge Works, of Rochester, who was on his way to New York, looking after the work his firm are doing for the Suburban Rapid Transit Company, north of the Harlem River, this city, the following interesting facts in regard to the late washout on the New York Central at Hoffman's Ferry, were learned:

The cloud-burst occurred about four o'clock in the afternoon, the great volume of water filling the gorge rapidly, scouring immense gulleys in the side hills and carrying the debris from the hills into the gorge. The tracks were rapidly submerged, and carried out within thirty minutes. By excellent management on the part of the Central people, no accident occurred to any train, they being held on each side of the break. The ravine above the bridge became blocked with timber and debris washed down from the hills. The water ran over the tracks, and two stone arches of twenty foot span and a considerable portion of the earth embankment on the east side were entirely carried out. Stones weighing fully two tons were carried two hundred yards below the bridge. Although the supporting earth and masonry were carried away, the ties and rails remained hanging in the air across the ravine, in perfect position for the entire four tracks, the ties held to the rails by the spikes, and the rails held together by the rail splices. The four tracks hanging in this novel manner across the ravine made a very interesting sight. The work of repairing the track, and particularly the attention given to the hurrying of the delayed passengers through to their destination by the Central people, was very noticeable. The work was pushed under the personal supervision of Superintendent Toucey and the Assistant Superintendent, Major Priest, and the interruption to traffic did not last over three days.

De Lesseps Report on the Panama Canal.

From the report M. Ferdinand de Lesseps made to the Counsel of Administration on July 29, the following items are gleaned:—

Count de Lesseps first reviews the statements made at each annual meeting since 1881, and reaffirms that the canal will be opened in 1888, and describes the present condition of the work.

In speaking of the cost of the finished canal, he uses 120,000,000 cubic metres as the total excavation to be done, though he thinks this can be reduced to 90 or 95 millions. From the existing contracts, under variable conditions, he figures the mean price of excavation at 3fr. 33c. per cubic metre; and adding to this a rate sufficient to cover the work done by the company direct, he puts the price of a cubic metre of earth at 3fr. 44c., and of rock, 8fr. 60c. At these figures the total cost of the canal would be 700,000,000 francs, say $140,000,000, on the day of opening.

"It will be necessary to add to this sum for excavation only, the expenses of administration and interest on the obligations, to arrive at the general total announced by the International Congress." This Congress put the cost in total of a sea-level canal at 1070 millions of francs, say $214,000,000.

In estimating revenue from the canal, M. de Lesseps figures on an annual traffic of 7,500,000 tons, at a rate of 15 francs per ton; or a revenue of 112,000,000 francs per annum, say $22,400,000.

The financial statement to June 30, 1884, is given as follows:

	Francs.
The expenses of the service in 1883-84, including the company charges, cost of administration and work done were	75,427,329.08
The assets have, according to estimate, been increased by	49,872,544.05
Including construction and the acquisition of material and stores during this period	125,299,873.13
The expenditure previous to this was	328,709,325.89
Making the total expenditure to June 30, 1884	354,009,199.02
From this sum must be deducted for unpaid debts and rediscount	26,809,154.64
Leaving total net expense	327,200,044.38
The resources, including the capital stock, the product of 250,000 bonds at 5 per cent., of Sept., 1882, and 600,000 bonds at 3 per cent., of Oct., 1883, with various assessory assets amounts to a total of	595,017,863.03
Leaving disposable assets of	267,817,818.65

This last sum is made up as follows:—

1st. Payments not due on stock	147,500,000.00
2nd. Undue payments on 3 per cent. bonds.	30,607,515.0
3rd. Disposible capital	89,710,303.65
Total as above	267,817,818.65

M. de Lesseps includes in his report a copy of his letter of May 27, 1885, to the Minister of the Interior. In this letter he says that the Panama Canal Co. now finds itself in the same situation as the Suez Canal Co., two years before the inauguration of the latter canal. He says almost the half of the effort necessary to finish the Panama Canal has been made. Of the 1071 million francs fixed by the International Commission as the total cost of the finished canal, 471,303,000 francs have been expended or pledged for work on the canal: all the sections are being worked, and 12,000,000 cubic metres of material have been extracted.

But, M. de Lesseps continues, the general public forgot that the period of organization, in all public works, is the most difficult and expensive: and that of the 75,000,000 cubic metres dug out from the Suez Canal, 50,000,000 was removed in the last two years. He then refers rather bitterly to the adverse reports of the foreign press, and gives a statement of the actual amount of bonds and stock afloat, the revenue estimated, etc., and finally asks the French government to authorize him, as President of the Canal Company, to issue further bonds for 600,000,000 francs, under similar conditions to those already floated.

The same number of the *Bulletin du Canal Interocéanique* contains an excellent map of the Isthmus of Panama, showing the line of of canal, the rivers and the Panama railroad, and also graphically illustrates the number and position of dredges, excavators, cars, railroad track, etc. A profile is also issued with the map.

The "Waterstaat" of Holland.

The corps of State engineers of Holland, corresponding to the *Corps des Ponts et Chaussées* in France, is called the *Waterstaat*. This term is assumed because hydraulic works are those which have most to do with the prosperity and even the existence of Holland.

The principal duties of the engineers of the Waterstaat are to defend the country against the sea, establish ports and canals, to regulate the navigation of streams and rivers, to construct dykes, locks and their accessories, to direct new drainage schemes and to assure and maintain those existing, and finally to construct and repair bridges and the principal roads and railways.

The corps is nominally made up as follows:—

Inspectors	3
Engineers in chief (Hoofd ingenieur)	12
" of the First class	18
" of the Second class	15
" of the Third class	8
Student engineers	6
Total	62

To enter the Waterstaat, it is first necessary to graduate at the polytechnic school at Delft, where the course lasts four or five years. The students who pass this school have a right to the title of "civil engineer," and from them

exclusively are recruited the engineers of the Waterstaat, whenever a vacancy occurs.

The work on the State railways is considered as temporary, and the engineers of the Waterstaat are assigned to them on detached service; or these places are filled by detached officers of the *genie* or military engineers, or by the national civil engineers. These engineers are engaged only for the time being on the special railroad work, and their duties give them no right to enter the Waterstaat. Only those who have actually been detached from this corps can re-enter it on completion of the detail work. The chiefs in charge of the State railways are called Principal Engineers, (*Eerstaanwezend—ingenieur.*)

The railway engineering staff varies according to the work being done; it comprises, usually, one Consulting Engineer to the Ministry, six Principal Engineers, fourteen Section Engineers and seven Assistant Engineers, a total of 28. The number of conductors (*Opzigter*) on the State lines is 70, with 50 auxiliaries.

The public works of Holland are under the charge of the Minister of the Interior, (*Ministerie van Binnenlandsche Zaken.*)

Memoires de la Societe Ingenieurs Civils.

The Haag Metropolitan Railway for Paris.

M. Haag, the projector of a metropolitan railway for Paris, in a late talk before the French Society of Civil Engineers, gives some interesting statistics relating to rapid transit in Paris.

The line suggested by him is generally an elevated structure with a portion in tunnel. For a viaduct in masonry, 50 feet wide, he estimates the cost at 4,500 francs per running *metre* of 3.28 feet, and the total cost at 50,000,000 francs. He proposes a rail weighing about 90 lbs. per yard, and estimates the cost of a double track way at 80 francs per running *metre*. Under his viaduct he would have a row of shops, facing two parallel streets, and these he estimates could be rented for 40 francs per superficial metre.

The expense of working the line he puts at 2f. 50c. per train-kilometre, or for each 3,280 feet; the average run of the trains circulating on the first line would be 7 kilometres, which would make the train expense 17f. 50c. The total cost of operating, for 800 trains per day, as figured by M. Haag, amounts to about 5,000,000 fr. per annum.

M. Haag shows that the movement of passengers by the present omnibus is 200,000,000 annually. So that at 25 centimes fare, 80,000,000 passengers would yield 20,000,000 fr.; and if the fare is lowered to 20 centimes, 100,000,000 would be required. In support of his estimate he says that the Ceinture R. R., between St. Lazare and Azztezzil, 8 kilometres long, carrys 15,000,000 passengers annually; in the same proportion the 21 kilometres of Metropolitan railway would carry 40,000,000. But he says this is too small an estimate as there is no comparison to be be made between the Azztezzil line and the business of a line as proposed.

A normal train would be made up of 10 cars, 6 second class and 4 first class, each second class car to contain 72 seats, and each first class, 24 seats; a normal train thus carrying 528 seated passengers. Figuring a total train expense at 17fr. 50c. plus 50fr. interest account, or 67fr. 50c., only 270 passengers at 25 centimes each would be required to meet expenses. This is a small proportion for Paris, where the omnibuses, with 26 seats in one type and 40 in another, average 36 passengers, and the tram-cars, with 48 seats, average 35 passengers.

An officer of the Lake Mistassinni exploring and surveying expedition reports its extreme length to be only 120 miles and its average breadth only 20 miles.

PERSONAL.

JOHN S. SHIPLEY, for ten years chief supervisor of the Georgia Railroad, is dead, aged sixty-five,

A. E. TOZALIN is the newly elected president of the Chicago, Burlington and Northern, and W. H. HOLCOMB general manager.

LORD SACKVILLE CECIL of England is making a tour of this country, gathering information in regard to the railroads of this country in general and railroad engineering in particular.

THOMAS IRWIN, wrecking master of the Richmond Branch of the Reading Railroad, died suddenly, August 17th, at his home 2505 Tulip street, Philadelphia.

CHARLES D. GORMAN, formerly with the North Western, has been appointed division superintendent of the Nickel Plate, with headquarters at Fort Wayne.

A report from Knoxville Tenn. states that JOHN F. O'Brien, general superintendent of the East Tennessee, Virginia and Georgia system, will resign by Sept. 1st. The news will create a sensation in railroad circles, as it is entirely unexpected.

W. H. WILEY, 15 Astor Place, New York, has personally assumed the American agency of *Engineering*. He announces that the journal will contain an increasing amount of articles by American engineers in addition to the regular articles by foreign writers. The subscription price has been reduced from $10 to $9 for thin paper and from $11 to $10 for thick paper. Mr. Wiley will keep a limited supply of back numbers on hand.

PROF. J. E. HILGARD, who has just resigned from his position as superintendent of the U. S. coast-survey, was born in Sweibrücken, Germany, in 1825. His father, a lawyer by profession, emigrated to Illinois in 1835, with a family of nine children, and was a man well known for his writings on social questions. J. E. Hilgard was educated as a civil engineer, and in 1845 entered the coast-survey: was specially interested in geodetic methods and the tides and terrestrial magnetism. In 1863 he was made a member of the National academy of science, and in 1872 took an active part in the international metric commission in Paris, and was made one of its permanent committee; and it was in that year he made a determination of the difference in longitude of Cambridge and Greenwhich by means of the Atlantic cable. At his suggestion, the series of transcontinental triangulations have been run connecting the surveys on the Atlantic and Pacific coasts,—triangulations which are serving for some of the state-surveys now in progress. Professor Hilgard was especially interested in the study of the Gulf Stream; and many will remember his paper upon that subject read at Philadelphia last summer, but not yet published. The success of the coast-survey is largely due to his work; and, since 1881, he has been the superintendent, from which position the misfortunes of ill-health compelled him to resign.—*Science.*

Lake Michigan Fluctuations.

There are some curious fluctuations in the surface level of the lake which have some bearing on the condition of the water in the river at such times. There is a periodical fluctuation of the lake depending on the wet and dry seasons, the changes in the water-level varying four feet and eight inches. An annual change is caused by the freezing and thawing of the lake, the water rising from May to August over eight inches, and receding during the rest of the season. The lake also rises correspondingly with a low barometer. The wind then rushes in and the water piles up ahead of it, causing a rise in the surface long before any wind is felt. Unaccountable fluctuations also occur, as in 1884, when in Buffalo the water of Lake Erie rose eight feet, drowning many people. A tidal-wave was noticed at Cleveland last year, and in July, 1885, the water rose twenty-eight inches. These fluctuations are a serious matter to deal with in managing the waters of a level river like the Chicago. Light southwest winds are the worst under the present systems of sewers, and the sewage floats under such a wind undiluted on the surface of the lake around the crib and sometimes far beyond it.—*Chicago Tribune.*

Gen. Anderson's Retirement.

It was definitely stated that Gen. Adna Anderson, engineer-in-chief of the Northern Pacific, had announced his intention of retiring from the service of that company several months ago. His resignation is now in the hands of the officers of the company. Gen. Anderson retires altogether from active life. He has been anxious to do so for several years, and does so at this time because the Northern Pacific has no important work on hand which cannot be carried out according to the specifications already prepared by him. The building of the Cascade branch is practically the only work the company has on hand. All the necessary plans and specifications were prepared by Gen. Anderson some months ago, and it will now be no trouble for the department, whether it remains an independent concern or not, to carry them out. Gen. Anderson has been with the Northern Pacific as Chief Engineer since February, 1880, and since that time has had charge of all the building done by the Northern Pacific, including the completion of its through trans-continental line. The general is probably the best known railroad engineer in the country, and has had charge of building some of the greatest railroads, and longest and largest bridges. He has been building railroads for very nearly forty years.

He is a native of Orleans county, New York. In 1847 he entered the service of the New York & New Hampshire, and shortly afterward was appointed assistant engineer of the Connecticut River road. After a year with that company, he went South and attached himself to the Mobile & Ohio. His stay there was but short, as he soon returned North, and for several years had charge of the construction work of the Ashuelot road of New Hampshire. He was next with the Michigan Southern & Northern Indiana. In 1852 he returned to the Mobile & Ohio as locating engineer. He continued in that position until 1855, when he was appointed chief engineer of the Tennessee & Alabama. Subsequently he occupied a similar position with the Central Southern and Edgefield & Kentucky roads. He was with the latter company from 1856 to 1860, filling the position of superintendent as well as that of engineer. In 1860 he went with the Henderson & Nashville, and in the following year took charge of the Edgefield & Kentucky road as receiver. After the war broke out General Anderson attached himself to the regular United States army. From June 1862, to February 1863, he was chief engineer of military railroads in Virginia, and from February to November 1, 1864, was general superintendent of the government railroads, military division of Mississippi. From November, 1864, he was chief superintendent and engineer of the military roads of the United States. After the war, Gen. Anderson associated himself for a short time with the Illinois & St. Louis Bridge Company. Leaving that company, he went to the Kansas Pacific, and remained in its service until May, 1871, when he was appointed vice president and general manager of the Toledo, Wabash & Western. In 1872, he was appointed vice president, and in the following

year elected president of the Lafayette & Bloomington. From May, 1875, to April, 1877, he was receiver of the Chicago, Danville & Vincennes; and from January, 1878, to October, 1879, general manager of the Paducah & Elizabethtown. From the last-named road he came to the Northern Pacific, having been elected its engineer-in-chief in February, 1880. —*Pioneer. Press*

Water and Sewerage as a Preventer of Typhoid.

At a late meeting of the Provincial Board of Health at Toronto, Canada. Dr. Oldright submitted some statistics with reference to typhoid fevers, comparing European experience with existing conditions in several Canadian cities.

The statement is as follows:

City.	Period.	Sanitary Condition.	Death Rate per 100,000 from Typhoid Fever.
Frankfort-on-the-Main.	1854-59	No sewerage	87
	1875-80	Sewerage completed	24
	1865-69	No sewerage; no proper water supply	108
Dantzic	1871-75	Water supply introduced	90
	1878-80	Sewerage added	18
Munich	1854-59	Absolutely no regulations for keeping the soil clean	24.2
	1860-65	Reforms begun by cementing the sides and bottoms of cesspools	16.8
	1866-73	Partial sewerage	13.3
	1876-80	Sewerage complete	8.7
Toronto	1881	.....	74
	1882	.....	69
	1883	.....	80
	1884	.....	65
Hamilton	1881	.....	65
	1882	.....	47
	1883	.....	30
	1884	.....	41
London	1882	.....?	110
	1883	.....	52
	1884	.....	65

In the three last cities the report states there is partial sewerage and water supply, but sewage not carried to a safe distance nor properly disposed of: many privy-pits polluting the soil and wells; refuse deposited in ravines and hollows; no skilled inspection of house drainage. Dr. Oldright contented that these figures showed the absolute necessity of the construction of a trunk sewer in Toronto to remove the sewage to a proper distance, instead of letting it run into the bay. Other sanitary precautions were also necessary to lower the high percentage of typhoid fever in this city. Although the report showed a lower rate per 100,000 in Hamilton, yet in that city diphtheria and scarlet fever prevailed to a much greater extent than in Toronto or London.

Steel Rails.

The continued depression in the steel rail trade has prompted the leading manufacturers to form an association to be known as the Associated Bessemer Rail Manufacturers. The first meeting of the association was held at Long Branch on Thursday Aug. 13, the companies represented being: Bethlehem Iron Company, Pennsylvania Steel Company, Carnegie Brothers (Limited), the North Chicago Rolling Mill Company, Joliet Iron and Steel Company, Union Steel Company, Cleveland Rolling Mill Company, Cambria Iron Company Lackawana Coal and Iron Company, Renssalaer Iron Company, Scranton Steel Company, and the Worcester Steel Company. The meeting developed the fact that the depression in the industry had forced two mills into the bankruptcy during the last eighteen months and forced two others to shut down. After a long interchange of opinions it was unanimously agreed to restrict the annual production to 750,000 tons so as to enable manufacturers to make rails at remunerative prices. The reduction will be based on the capacity of each mill and will go into effect January 1, 1886. It is understood that a leading feature of the combination will be the making of all sales through the medium of a committee following the English and Dutch plan, now in force, whereby orders are apportioned to the mills in proportion to their various capacities and advantages of location as to freight rates.

The Great Guns of the Day.

THE following table, taken from the *Armeeblatt*, gives an interesting comparison between the largest guns at present existent:

Type of Gun.	Calibre.	Length of gun.	Weight.			Inital Velocity.	Total energy at the muzzle. per kilogramme of the weight of gun.
			Gun.	Shot.	Chrge.		
	Min.	Met.	Kilogrammes.			Met.	
Krupp 35-cal. 30.5 c.m.	305	10.70	48550	455	141	530	.104
Krupp 35-cal. 35.5 c.m.	355	12.40	81350	725	225	530	.103
German 30.5 c.m. mar.	305	6.70	36600	325	72	488	.103
Russian 12in. (long).	305	9.14	43341	344	128	597	.14
French pat. 1870 32 c.m.	320	6.70	39000	341	86	470	.104
English 80 ton m. l.	406	8.15	82300	771	204	498	.114
English 63 ton b. l.	343	10.97	64000	567	283	624	.175
Italian 100 ton b. l.	432	11.89	103100	908	300	558	.118
French pat. 1875 34 c. m.	340	6.7	48340	420	117	480	.101
Bange 34 c. m.	340	11.20	37500	450	180	600	.221

A correspondent of *Broad Arrow* introduces another element of comparison, that of rapidity of fire. He says: "The calculations of the power of guns, as given by Colonel MAITLAND in his paper on "The Heavy Guns of 1884" read at the United Service Institution, are utterly misleading, as they leave out of account all consideration of rapidity and safety of firing; in fact, they gave only the efficiency of the gun for a single round, thus placing a gun that could be fired only one round per hour on an equality with another gun firing a hundred similar rounds per hour. The Krupp gun is calculated to fire one round every ten minutes from his large guns on the practice ground at Meppen, and Captain FITZGERALD. R. N., stated in his lecture at the United Service Institution that the English 100-ton breech-loading gun could be fired only once in fifteen or twenty minutes." He institutes the following comparison to show the difference between a gun firing six shots an hour and an ideal gun ("Gun of 1886") supposed to fire 20 shots in the same time:

Data.	Elswick Gun of 1884.	Gun of 1886.
Diameter of bore	16.25	16.25
Weight of gun	110 tons.	120 tons
" charge	900 lb.	900 lb.
" projectile	1,800 lb.	1,800 lb.
Muzzle velocity of projectile	2,020 ft. per sec	2,020 ft. per sec
Muzzle energy of projectile	50,924 ft. tons.	50,924 ft. tons.
Muzzle energy of projectile per ton of gun	513 ft. tons.	424.3 ft. tons.
Number of rounds fired per hour	6	20
Total power of gun	305,544 ft. tons.	1,018,480 ft. tons.
Power per ton weight of gun	2,777 ft. tons.	8487.5 ft. tons.

This table shows that the more rapid firing gun, although not 10 per cent. heavier than the Elswick gun, is over 200 per cent. more powerful for destructive purposes.

THE Florida Southern R. R. Co., is bending its every energy towards the early completion of its road to some point on the coast near Charlotte Harbor. About one thousand hands are employed on the work.

The Fastest Railway Speed.

There have been so many reports as to the speed attained by fast railroad trains, and the conditions under which such runs were accomplished, that it is pleasant to be able to give full official details of a train speed attained on July 9th, over the West Shore Railroad, which at least seems to "beat the record," so far as this Continent is concerned. It was a special train, run from East Buffalo Junction to the New York terminus of the road, 422.6 miles, at the average rate of 54.66 miles per hour while the train was in motion, but the remarkable speed attained was in the run from East Buffalo to Frankfort, N. Y., a distance of 201.7 miles. This whole distance was made, excluding stops, at an average speed of 59.63 miles per hour. The fastest speeds were between Buffalo and Genesee Junction—60.9 miles in 56 minutes, or at the rate of 65¼ miles an hour, while the last 36 miles of the distance was run at the average rate of 72.6 miles per hour. These figures are from the train sheet, as furnished by W. W. Wheatly, the chief train dispatcher, but there were also on the train, officials of the Baltimore and Ohio, Wabash and Grand Trunk roads, some of whom kept a careful record, and reported that several miles were made in 43 seconds each. The train was made up as follows:

	Approximate weight.
1 N. Y. W. S. & B. baggage car	32,000 lb.
1 " " " private car (No. 90)	56,000 "
1 Baltimore & Ohio " "	56,000 "
Total weight of 3 cars	144,000 lb.
Tender 34,000 lb. empty; 20,000 lb. load (two-thirds of full load)	54,000 lb.
Engine (62,500 lb. on 4 drivers)	94,500 "
	148,500 lb.
Total weight of train	292,500 lb.

Details of engine. Class B. N. Y., W. S. & B. Ry.:

Cylinders, 18 x 24 in.

Drivers (4) 68 in.

Firebox (inside), 5 ft. 10¾ in. x 2 ft. 10½ in.; 17 sq. ft.

Tubes, 188, 2 in. exterior diameter, 10 ft. 10½ in. long. Heating surface, exterior tube area, 1,084 sq. ft., total 1,212 sq. ft.

Boiler, 56 in., average diameter, 17 ft. 6 in. extreme legth

Smokebox, extended, 6 ft. 2¾ in. x 59 in.

Market Street Bridges, Philadelphia.

In 1776-7 General Israel Putnam built a bridge of the floating stages used by ship carpenters at what was then known as the Middle Ferry. This was removed on the evacuation of the city in 1779. It was subsequently replaced several times before any steps were taken to render the bridge permanent. A company was organized March 16, 1798, with a capital of $150,000, and it proceeded to erect a wooden bridge from designs prepared by Timothy Palmer.

It was completed and opened Jauuary 1, 1805, at a cost of nearly $300,000. In 1840, it was sold to the city for $80,000, and made "free." In 1849 it was remodelled and strengthened to carry the tracks of the Penna. R. R. Co., and continued to do good service until destroyed by fire Nov. 20, 1875.

The Penna. R. R. Co. was authorized to rebuild a bridge on the old piers, and in December of the same year, completed the present structure, a Howe truss of three spans, in 207 working hours. This was guaranteed to last five years. It has stood nearly ten, although additional members have been added since its completion.

A novel feature consists in a long truss rod applied to the middle span and extending from end to end of top chord, passing over a cradle under the center of the bottom chord. The braces have also been strengthened by planks spiked to their faces. Recently there has been a very perceptible settling in the south side of the west truss at the first panel

point, caused by the decay at the foot of the main brace, part of which has broken off at the floor level and at the intersection with the counter brace, causing a settlement of six inches or more. The temporary bridge, completed this spring is now in use, and the Howe bridge is closed awaiting the decision as to its successors stone, iron or steel.

CORRESPONDENCE.

The Topography of Machines.

COLUMBIA, S. C. Aug. 3, 1885.

EDITOR ENGINEERING NEWS: In hopes that my practice and ideas may be of some benefit in developing the "Topography of Machines."—see Mr. Oberlin Smith in your issue of July 25, 1885.—I send you the following:

In taking a measurement and description of a machine or an object for future use, my system is based upon the first principles of Descriptive Geometry. Two planes of projection, horizontal and vertical, form the groundwork; the intersection of these planes called the ground-line, and four dihedral angles formed by the intersection of the planes. The point of observation is in the first angle, that is above the horizontal plane and in front of the vertical plane. The object to be measured is placed in this angle, between the eye and the planes of projection, touching and not extending back or below them, when possible.

A point in the ground-line (*G L*), called the initial point (*I*), is assumed to the left of the object to be measured; so located that a vertical plane, at right angles to the plane of projection, containing this point would pass through the extreme left point of the object. All measurements are made on the lines of horizontal and vertical projections of the point sought, and are referred to the initial point by the distance from it to the point of intersection of the ground-line of the plane containing the projecting, or measuring lines of the point.

In recording measurements, the following terms and abbreviations are used:—

I.—Initial point.

F. Front of plane; that is, from the vertical plane towards the observer.

B.—Back of plane; that is, from the vertical plane and observer.

A.—Above plane; that is, above the horizontal plane.

U.—Under; under or below the horizontal plane.

R. I.—Right of initial point; along the ground-line in direction of right hand of observer.

L. I.—Left of initial point; to left of initial point in the direction of left hand of observer.

In recording the measurements of an object placed as above stated and referred to the planes, etc., only the abbreviations *I, R, I* and *A* need be used; but if additions are to be made afterwards, then in describing them it might be necessary to use all the terms; for this addition might be to the left of the initial point, to the back of the vertical plane, or under the horizontal plane. It should be observed that the terms *F, B, A* and *U* are only used in reference to the planes of projection, and *R. I* and *L. I* in reference to the right or left of the observer with reference to the initial point. The *R. I* and *L. I* are generally further abbreviated to *R* and *L*.

In practice it is best to measure and locate the principal framework for machine by reference to the primary planes of projection, ground-line and initial point; then assume a line on the surface of some prominent feature as a secondary ground-line, with its planes of projection and initial point. The observer takes position as before in the first angle of the second system with his left hand towards the primary initial point; then he makes as many measurements as may be convenient and, if advisable, establishes other reference points on the same system from which to measure.

In locating the position of many members of a machine, but few measurements are necessary; for example, a shaft can always be established by two sets of measurements and, when parallel to the ground line, by one. The position of pulleys, or other features on said shaft, may be determined by reference to some point on it, fixed when the position of the shaft was located; the relative positions, right or left, being the same as were used when the shaft was located. The dimensions may be measured and referred to some fixed point, as a center, or center line of the object to be measured.

The notes taken are recorded in columns headed with the abbreviations used, each under its appropriate heading; measurements referring to the same member should be placed consecutively and coupled together, prefaced by any explanatory or simplifying remark desired. The initial point to which the measurements are referred, should be placed conspicuously at the head of the notes, using the letters *I. P., P.*, as the case may be.

These are the general principles of the system used in my own practice; there are many minor details which will suggest themselves in simplifying and shortening the work. The position of the object is absolutely located and fixed by the projecting planes and their intersection. The measurements are arranged in columns under headings named, so as to show exactly what is meant, and it is practicable to make a complete record of an object by words and figures without a drawing.

This system is similar to the one proposed by Mr. Smith; it is simple and practical, with a certainty, when properly used, of having everything exactly right and ready to be re-produced when needed.

In practice, the wall and floor of a room, where the object is, can be used for the planes of projection and their intersection, the ground line, in which establish the initial point. With a few measurements the exact location of the object will be determined, when a secondary ground-line, etc., may be established on the object, and with two common carpenters squares, with levels attached, any further measurements may be made.

The using of more than one initial somewhat complicates the future projection of the notes in plan and elevation, but this difficulty is easily overcome and its use is fully justified by its great convenience in taking notes. In projecting the notes in plan and elevation, the eye is supposed to be placed at an infinite distance from the plane in which the projection is made, and the vertical plane is revolved on the ground line from the observer. On the drawing the ground-line and initial point are fixed and all positions referred to them.

THOMAS B. LEE, C. E., M. E.

Grants Monument.

NEW YORK, Aug. 20.

EDITOR ENGINEERING NEWS.—After a quiet survey of the field I feel constrained to say a few words on the subject of a monument to General Grant.

Before his death it seems he had expressed a wish to be burried in New York City, and with the hope expressed, that his wife might ultimately be laid to rest beside him in the same grave. We have seen with what enthusiasm the authorities and the people of this city have responded to this expression of his wishes, and provided a resting place in accordance therewith, and where his body now lies. There appears to be no dissent from the generally expressed opinion that the locality selected is a most fitting one—indeed, probably unequalled by any other available site which could have been selected, and there only remains to consider how and in what manner, art shall best lend her aid to nature, in emphasizing beauties already unrivalled and consecrating the spot for all time to the sole memory of the dead soldier—a spot already regarded by his countrymen as sacred ground, and to which the eyes and steps of future pilgrims will turn as to a Mecca from whence shall emanate fresh impulses to patriotic deeds.

Whether the monument to be erected at this spot will be a national one, may be doubted. Subscriptions will pour in—more or less freely, from all parts of the country, but the enthusiasm which now prompts them will subside long before an adequate sum is realized, and it will probably be left to the pride of the metropolis to furnish the means for completing what the spontaneous sentiment of the entire people now regard as but a fitting tribute to the memory of their great soldier and patriot. Hence an estimate of the sum which can properly be expended on the work, would, at this time, be but an idle conjecture, and we will forego any consideration of it.

Ambitious architects, without number, of home breeding and of foreign importation, will submit plans in competition, and before the rubbish can be sifted out, and anything like a decision reached, the public will be nausiated with the vapid twaddle of self elected art critics and judges, and it would be strange indeed, if, after all the turmoil over the matter, the American system of deciding such things resulted in anything higher than a third, or second rate design, but endorsed by some first rate humbug in art policy.

To avoid all this possibly disgraceful underhand mismanagement, I would beg leave to propose a return to first principles, and sweeping into the waste basket the reams of elegantly drawn landscape designs, overloaded with architectural vagaries, whether of obelisk, shafts, columns domes, Parthenons, or Pantheons, and recommend instead of any or all of these the construction of a simple massive granite pyramid, without entrance or opening of any kind, and devoid of all effigy, ornament or inscription, whatever,—not even, "let us have peace," but impressive by its mass and simplicity of outline, and on such a scale as to become a feature in the grand landscape. Such a structure would alike defy the ravages of time, the neglect of municipal repairers, or the assaults of a evil disposed mob. Its appropriateness as quietly illustrating the simplicity and dignity, without recourse to adventitious aids, of the character of the man in whose memory it was raised, is no less apparent, than the eternal duration which its form and mass suggest, as an emblem of the lasting regard in which he would be held in the hearts of his countrymen.

No drawing to scale is needed, nor would a model ten feet square—nor fifty feet—nor a hundred feet square be of any service towards illustrating the effect of such a monument, but, a dimension could be had, if the fund would justify it, which would belittle any architectural composition the modern architect could devise.

J. W. A.

A DAM ACROSS THE POTOMAC.

A Court Decision Regarding the Water Supply of Washington.

Judges Bond and Morris, of the United States Circuit Court, August 10th, announced their decision in the case of the Great Falls Manufacturing Company, of which General B. F. Butler is President, against Secretary of War Endicott, Garrett J. Lydecker, George B. Chittenden and Samuel H. Chittenden. The Judges denied the application for a preliminary injunction to restrain the defendants from erecting a dam across the Potomac river at Conn's Island, and other structures intended to afford an increased supply of water to the city of Washington. The work was authorized by an act of Congress approved July 15, 1882, and under this authority the Secretary of War appointed Major Lydecker, of the United States Engineer Corps, to supervise the same. The defendants Chittenden are the contractors. The case was argued before the court in May last, by General Butler, ex-Secretary of the Navy Robeson and O. D. Barrett for the Great Falls Company, and United States Solicitor General John S. Goode and Assistant Attorney General John S. Blair for the defence.

The complaints, which claimed its water privileges were seriously impaired, urged that the act of Congress was unconstitutional, or, conceding its constitutionality, that there was a failure to pursue its terms; that the act made no provision for the verdict of a jury as to the amount of compensation, which was held to be a constitutional right, and that the Court of Claims, specified as a place of resort for the adjudication of all claims arising under the act—a court unknown to the Constitution, being neither a court of equity nor of common law, and not different than a board of referees constituted by one party to hear and determine such cases as another party shall choose to submit to it, etc. With regard to the claim that complainant is entitled to have his compensation assessed by a jury, says the court, has been so often decided as not to be regarded as an open question. In condemnations of private property for public use, in the exercise of the right of eminent domain, neither by the provisions of the Constitution of the United States guaranteeing the right of trial by jury in common law cases, nor under the provision forbidding a citizen being deprived of his property without due process of law, nor under similar provisions in the constitutions of states has it been held that a trial by jury is requisite.

"We think it equally clear," says the court, "that there is no valid objection to the Court of Claims as a proper, impartial tribunal, designated by the act, and possessed of all the requisite means to investigate and determine all the questions which can arise in respect to the complainant's claim. The court further decides that a proper survey was made and was accessable to the public, and that the advertisement sufficiently and clearly stated what the United States proposed to acquire, including the water rights attached to the land proposed to be taken. The complainant having filed a claim in the Court of Claims asking compensation for the land, water rights and water appropriated, waived all objection to the preliminary steps for estimating that compensation, and as the act provides that the claimant may file such a claim if for any reason the claimant shall not have been tendered payment or shall have declined to accept the amount tendered, it seems to the

court that the complainant is now before a tribunal—the Court of Claims—which can hear and adjudicate its claims, can consider the testimony of its witnesses, pass upon its titles and pretentions with respect to the water to be diverted from the river, and award the just compensatien to which the complainant is entitled. In regard to the right of compensation before entry, the government having expended large sums of money during the eighteen months within which the complainant did not seek to estop the same, the court regards this as one of the cases in which to relax the rule requiring payments to precede entry, especially as the land and water rights of the complainant were not and never have been used in any beneficial manner, but have remained unimproved and vacant, and the complainant having expressed his willingness to sell such rights to the United States. Finding the act itself valid, and, for the above and other reasons, the court refuses the preliminary injunction prayed for, closing with the remark that "if the complainant is so advised, this cause may be continued, as that hereafter if it should indeed prove to be true that a certain and adequate provision has not been made for payment of the amount which shall be ascertained to be due the complainant, the further action of this court may be invoked."

TIMBER IN THE STRAITS SETTLEMENTS.—Mr. Howard Newton, assistant municipal engineer, of Singapore, has published a series of notes and experiments on the different kinds of timber in ordinary use in the Straits Settlements. The pamphlet contains observations on the forests adjoining our colonies in the Malay Peninsula, and the need already of conservation. The trees are felled in large numbers for ordinary use, and the jungles are cleared and exhausted by the Chinese gambia and pepper planters. Twenty specimens of woods are then described in detail, and finally an account of the mode in which the experiments were conducted and elaborate tables of the results follow. The breaking weights of some of the timbers tested were as follows:—1850 lb., 1836 lb., 1656 lb., 1374 lb., 1286 lb. and 1284 lb. Notes on the toughness, fracture, deflection, etc., are also given. It is curious to notice that some of the finest trees near Singapore—in the Johore forest—have no botanical equivalents. Mr. Newton specially mentions a tree called by Malays the *ballow*, which grows from 60 ft. to 160 ft. in height, with a diameter of 3 ft. to 6 ft. It is a close-grained, tenacious, hard, heavy wood, very valuable for building. It is called popularly Johore teak.—*The Engineer.*

"GRANT'S MEMORIAL: what shall it be?" is discussed in the September number of the *North American Review*, by Launt Thompson, Karl Gerhardt, O. L. Warner, and Wilson Mc Donald, sculptors; W. H. Bearn, painter: Calvert Vaux and Henry Van Brunt, architects; and Clarence Cook, art critic. This symposium is sure to attract wide attention at this time, when the desire is so general to erect a monument to Grant that shall be worthy of the man, the nation, and the American art. The same number of the Review contains a consideration of the question, "Shall our National Banking System be Abolished?" by George S. Boutwell, F. J. Scott, S. Dana Horton, and Edward H. G. Clark. "Ouida" contributes an essay on "The Tendencies of English Fiction," and Elizabeth Stuart Phelps writes on the "Great Physical Opportunity." But the most readable article in the number is ex-Seargent-at-arms French's "Reminiscences of Famous Americans," which is a series of delightful anecdotes about the famous war senators. Mr. French is writing a book or these reminiscences. If it equal this forestallment in the Review, it will be one of the famous works of modern literature.

The First Railroad in America.

The *Globe Democrat* says: "In the course of a paper read before the Franklin Institute, bearing the title, 'Transportation Facilities of the Past and Present,' Mr. Barnet LeVan corrects the commonly received statement that the Granite Railroad, built at Quincy, Mass., in 1827, by Gridley Bryant, for transporting stone for the Bunker Hill Monument from the granite quarries of Quincy, was the first railroad built in the United States. On this point he presents interesting testimony to prove that, far from being the first, the Granite Railroad was really only the fourth in order of precedence in the United States. We quote from that portion of the paper relating to the subject as follows:

"Railroads were also first introduced in Pennsylvania. In September, 1809, the first experimental track in the United States was laid out by John Thomson (the father of John Edgar Thomson, who was afterward the President of the Pennsylvania Railroad Company), Civil Engineer of Delaware County, Penn., and constructed under his direction by Somerville, a Scotch millwright, for Thomas Leiper, of Philadelphia. It was 180 feet in length, and graded 1½ inches to the yard. The gauge was four feet, and the sleepers eight feet apart. The experiment with a loaded car was so successful that Leiper in the same year caused the first practical railroad in the United States to be constructed for the transportation of stone from his quarries on Crum Creek to his landing on Ridley Creek, in Delaware County, Penn., a distance of about one mile. It continued in use for nineteen years. Some of the original foundations, consisting of rock in which holes were drilled and afterward plugged with wood to receive the spikes for holding the sleepers in place, may be seen to this day."

THE GREATEST GUNPOWDER BLAST in connection with railway works was that by which Sir William Cubitt blew away with one charge of 19,000 pounds of gunpowder the entire mass of the Round Down Cliff, which rose to the height of 350 feet above the level of the sea, within a few miles of Dover. This monster blast, fired by electricity at several points at once, tore from the cliffs a mass of more than a million tons of chalk.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 108*).

Results calculated for speeds varying from 10 to 60 miles per hour and curves from 1° to 20° are given in Table No. 7.†

Unless the traffic is all done at about the same rate of speed, or the freight and passenger trains are run on seperate tracks, it is impossible to adjust the elevation to suit all rates of speed, especially as they are liable to vary within such wide limits, and the question arises whether it is advisable to set the curves up for the fastest trains or to select some average rate as the standard. Unless the freight interest greatly predominates, the former is preferable for the sake of the train itself, because the fastest trains are those which should be favored most; for the comfort of the passengers, because the disagreeable sensations of a flat curve are in proportion to the square of the speed; for the saving of the track, because in this same proportion is also increased the power of a train to injuriously affect a curve by throwing it out of line, unless it is set up to the rate of speed. The use of this table necessitates the knowledge of the degree of each curve, information which is not always obtainable, but since the lack of proper elevation can easily be detected by a person riding either on the engine or on the rear platform of a train, whose speed is the standard, a good every day rule for roads where the degrees of curvature are not known is "to put the curves up till they ride right." But if, previous to the beginning of the work of elevating a curve, there is doubt as to what is right, the old and practical method of stretching a cord between any two points on the inside of the outer rail and measuring its middle ordinate can be used. The formula for this (taken from Searles) for 4 feet 8½ inch gauge is

$$\text{Length of string} = 1.587\ V$$

By substituting in the place of V the speed of the fastest train the result will give the length of string required. For forty miles per hour the length is 63½ feet. Of course, to use this method, the course must be in line, or else several measurements must be taken in order to get a fair average. The most satisfactory way is to know the degree of curvature and to take the proper elevation from the table. For the benefit of the trackmen the degree of the curve can be marked on the telegraph poles nearest the points of curve and tangent.

It is not necessary to elevate very sharp curves at the same rate as those of longer radius, because it would give a very excessive amount for slow trains, and is not demanded by the fast trains as their rate of speed would be naturally decreased on passing around a heavy curve. Thus in addition to deciding on a rate of elevation per degree of curvature, it should also be decided at what radius this rate can be diminished, and what should be the extreme limit the allowable amount of elevation. These three questions depend on conditions of traffic and ruling curvature, but in general it is well to begin and diminish the rate after curves of 5° or 6°, and to have no elevation greater than about 8 inches, which is equivalent to a 10° curve at 35 miles per hour.

(TO BE CONTINUED.)

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY JAMES R. CROES, M. SOC. C. E.; INST. C. E.

(CONTINUED FROM PAGE 108)

DCLXX—SILVER CLIFF, COLO.

Silver Cliff, Custer Co., Colorado, in lat. 38° 5′ N., long 105° 15′ W. is in a mountainous region rich in silver mines.

Water-works were built by the town in 1879 the supply being taken from springs and also from Grape creek. The water is pumped directly into the mains by a Holly Steam Pump.

Distribution is by 8 miles of cast iron pipe with 24 fire-hydrants and 200 taps. Service pipes are of wrought-iron. The daily consumption is 40,000 gallons. No meters are in use.

The cost of the works has been $75,000. The bonded debt is $85,000 at 10 per cent. The yearly expenses and receipts are $5,000. The population in 1880 was 5,040, O. Carstarphen is Superintendent.

DCCLXXI.—SIOUX FALLS, DAK.

Sioux Falls, Dakota, in lat. 43°-40 N., long. 96° 35′ W., the county-seat of Minnehaha Co., is in a region of nearly level prairie land on Big Sioux River.

Water-works were built in 1884 by a private company, taking the supply from a well 30 feet in diameter, fed by a spring. Thence the water is pumped by a Worthington pump of 750,000 gallons daily capacity, driven by water power from the Big Sioux River to a tank holding 100,000 gallons at 110 feet above the business part of the town. There is also a

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†This Table is unavoidably laid over till next week.

compound Worthington steam pump, of 1,000,000 gallons capacity used as an auxiliary.

Distribution is by five miles of cast-iron pipe of 12 to 4 inches diameter, with 43 fire-hydrants and 40 taps. Service pipes are of lead. The town pays $75 yearly for the use of each of the first 40, and $65 for each additional hydrant.

The works have cost $65,000. The bonded debt is $60,000 at 6 per cent. The population in 1880 was 2,164, and is now said to be 6,000.

A. W. Mellon is President, and W. S. Kulm Secretary and Treasurer.

DCCLXXII. SOUTH ABINGTON, MASS.

South Abington, Plymouth Co., Massachusetts is in lat. 42° N., long. 70° 45′ W.

Water-works were built by the town in 1883, taking the supply from Hobart Pond, which is mainly supplied from springs. The water is pumped by a Worthington steam pump of 1,250,000 gallons daily capacity to an iron tower 20 feet in diameter and 105 feet high.

Distribution is by 8 miles of sheet iron and cement pipe with 60 fire-hydrants, 50 meters and 145 taps. Service pipes are of iron. The works have cost $50,000, which is the amount of the bonded debt at 4 per cent.

The town pays $25 yearly for the use of each hydrant.

H. F. Whidden, Chas F. Allen and Chas. D. Nash are the water commissioners.

DCCLXXIII—SOUTH EVANSTON, ILL.

South Evanston, Cook Co. Illinois, in lat. 42° N., long, 87° 45′ W.

Water-works were built in 1884 by the village taking the supply from an artesian well 1602 feet deep. The well is 6 inches in diameter for 1,236 feet and 5 inches for 366 feet, and flows 24 feet above the ground surface, yielding 370,800 gallons in 24 hours.

Distribution is by 8 miles of cast-iron pipe with 58 fire-hydrants and 200 taps. Service pipes are of lead and galvanized iron. The daily consumption is 200,000 gallons.

The well cost $3,840, and the distribution $40,000 making the total cost of the works $43,840. The bonded debt is $17,000 at 5 per cent. The yearly expenses of maintenance are $1,000.

C. M. Cass is chairman of the Water-works committee and John Watson engineer of the works.

WATER

THE tank of the new water-works at Brunswick, Ga., will have a capacity of 100,000 gallons.

THE Willimantic (Conn.) Water-works are nearly ready for the pumping machinery.

SHIPPENBURG, Pa., projected water-works can be built for $25,000.

A GAS company has been formed at Girardville, Pa., and the works will be running in three months.

THE Rapid City, Dak., water-works are to be completed Jan. 1886.

The Lincoln, Neb., city council has awarded the contract for sewerage plans to Chester B. Davis.

PUTTSELL & KILLIAN, of Boston, have the contract for digging the water works well at Middleboro, Mass., for $4,000.

THE Pond Engineering Co., St. Louis, have been awarded the contract to furnish the entire pumping machinery plant for the Mexico, Mo., water-works.

THE pipes for the water works at Houlton, Me., are nearly laid. Work was begun last week in laying service pipes for the introduction of water into buildings.

THE Paducah, Ky., water-works will be ready for operation by the 1st of December. Work is being pushed forward rapidly.

THE geological survey party have discovered a spring of white sulphur water of exceptionally fine quality at Orangeburg, Mason county, Ky.

THE Curtis Regulator Co., of Boston, Mass., has just finished a large Pressure Regulator for the Water-works of the City of Moscow, Russia.

THE Slocum Water Company just chartered, has made a contract with a Philadelphia firm for the building of a reservoir of 500,000 gallons capacity to furnish Tunkhannock with water. Work will begin next week.

GREEN river, Wyoming, is putting in $4,000 worth of water pipe to connect with the Union Pacific pumps, to supply the city with water for fire and domestic purposes.

THE citizens of Greeley, Col., have decided to form a stock company for the purpose of supplying the town with electric light. The plant is to cost $20,000 and already one-half of the 300 shares have been taken at $50 per share.

THE contract for repairing Kohanza and Pandanaram dams has been awarded by the water commissioners to Wright & Hughes, of Newtown, Conn. It is expected that the work will be commenced at once.

BROCKTON, Mass.—The *Gazette* has agitated the subject of surface irrigation as a sewerage system, and strongly advocated the purchase of Matfield swamp by the city, as conducive to the future health and prosperity of the city.

THE following papers were filed August 10, in the office of the Secretary of State, of Colorado.

The Dixon Canon Ditch and Reservoir Company; to construct and maintain a ditch and reservoir in Laramer county, with Dixon Creek as the water supply.

THE city council of Rochester, Minn., has voted to engage Mr. H. H. Harrison, of Stillwater, to prepare plans and specifications for the proposed water-works, in order that the city may have something definite to figure on in this matter.

THE new water-works at Bismarck, Dak., are estimated to cost $100,000, and will not be completed this year. The water of the Missouri is to be pumped into a reservoir 144 feet above the business part of the city, which will carry it to any building.

IT is reported that the Minneapolis Mill company have sent East to engage the services of another hydraulic engineer in taking measurements of water at the West side pumping station. D. P. Waters, the engineer employed by the city, has nearly completed his measurements.

CONTROLLER LOEW has advertised for proposals for $1,000,000 of additional water stock of this city, interest payable semi-annually at the rate of 3 per cent per annum. The new issue is authorized by chapter 490 of the Laws of 1883, which provides for the construction of a new aqueduct. The stock is exempt from city and county taxation, and the principal is payable on Oct. 1, 1901. Proposals will be received for any amount in sums of $1,000 or multiples thereof.

DALTON, Ga., is arranging to build a windmill at the park, at a cost of several hundred dollars. The intention is to build a tank with sufficient capacity and height to supply the business portion of the city with water, as well as the public buildings, and also for use in case of fire, wherever the pipes may communicate. There will also be a fountain in the park, which will be a great attraction. This makes a system of water-works upon a small scale, and of course cannot be general, but will be of great convenience in the public places, and about the immediate center of business.

A DISPUTE has arisen between the Bridgeport, Conn., Water Company and the Bridgeport Paper Company regarding the ownership of a chimney which both have jointly used for many years. The paper company wish to pull down the chimney and build a larger one, and on Sunday they began to pull it down, but were restrained by an injunction signed by Judge Granger, of the Superior Court. The water company claim that they cannot afford to do without a chimney, even for a single day, as more than 40,000 people depend upon the company for a supply of water.

NEW ORLEANS, Aug. 12.—The City Council last night voted to accept the bid of the Louisiana Electric Light and Power Company for 528 pole lights at $115 per pole per annum, for lighting the suburban districts of the city, and the mayor was authorized to make a contract for two years. This is recorded as the cheapest bid proposed. The competitors were the Brush Electric Light Company and the New Orleans Gaslight Company the latter of which has had the monopoly for many years. New Orleans is probably the first city of its size on the continent to adopt electric lighting for all purposes.

THE subcommittee of the Citizens' Sanitary Committee of Chicago, appointed to draft the report of the association on the investigation of the Chicago River and its branches, has submitted a preliminary report, in which it is stated that a daily sewage product estimated at 60,000,000 is accumulating: that the Desplaines waters are flowing into the south branch at the rate of 40,000 gallons per minute, and that in a short time, aided by southwest wind and a lowered lake level, these waters will flush this accumulation of sewage into the lake. It is suggested that an expenditure of $250 and the labor of a dozen men for one day would erect a temporary dam at the entrance to the Ogden and Wentworth ditch, which would exclude the Desplaines from the south branch at the present time, rendering it practicable to operate the Bridgeport pumps upon the sewage of the city at once.

WASHINGTON, August 14th.—THE annual report on the water supply extension says that the appropriation for the Great Falls dam was $145,151, and the unexpended balance of $56,551 is sufficient to complete it. The time for the completion of the tunnel has been extended to June 30, 1886. The total cost up to date has been $418,125, of which $339,768 were expended during the year. When completed it will be 20,715 feet in length with an average depth below the surface of the ground of one hundred and fifty feet. An additional appropriation will be required to finish the tunnel of $395,000. The original appropriation for the reservoir was $431,274, of which $180,155 remains unexpended, and it is estimated that a further appropriation of $195,000 will be needed.

ARTESIAN WELLS IN SAHARA have been used from a very remote period, and in the Algerian Sahara additional wells have been opened with considerable success by the French. Between Biskra and Tuggur thas 434 old wells yielded in 1879, 60,000 litres of water per minute, the 63 French ones 113,000 litres. The number of palms had increased from 327,000 to 518,000, that of other fruit trees from 50,000 to 90,000, the population from 6675 to 12,827. In December 1881, the yield of water from the wells had risen to 209,000 litres per minute. But this success is confined to a narrow zone within which water can be reached within a depth of 100 meters, and even here the borings that have been made since 1881 indicate a diminution in the yield of water, making it appear as if the limit of production of the underground reservoirs had almost been reached. Many of the French borings, too, are getting stopped up by sand, and are of too small caliber to be cleaned out and restored like the wider Arabic ones. It is believed that it will be absolutely necessary to set about the sinking of new wells with a wider bore.

NEWS OF THE WEEK.

Contracting.

New Iron Draw.—The contract was awarded Aug. 14, by the Chosen Freeholders of Bergen and Passaic Counties, N. J., for a new iron draw in the Rutherford Park bridge over the Passaic river for $7,992. A number of bridge builders competed and the bids were exceedingly low.

Dry Dock in Valparaiso.—It is reported that the Chilian Government will appoint a commission of engineers to study the best way of constructing a dry dock in Valparaiso. The dock must be capable of holding seven ships and have a depth of eight meters.

The B. & O. Bridge Across the Schuylkill.—The contract for building the masonry piers of the Baltimore & Ohio bridge across the Schuylkill River has been let to Drake & Stratton, of New York. In some cases it will be necessary to sink the wooden caissons 60 feet through the deposit of silt before bed-rock is reached.

R. R. Contract.—BELLE PLAINE, KAN., August 14th.—Sixty-one miles of the Denver, Memphis & Atlantic Railway were sublet here yesterday, to be completed and ready for operation by December 1st. This is a portion of a new road to be built from Denver to Memphis direct. Messrs. Fitzgerald and Mallory have a contract to complete 325 miles. Four hundred teams will be at work next week.

Awards for Furnishing Cement.—Awards for furnishing the sewer department of Boston, Mass., with cement for West Roxbury and Dorchester have been made to Curtis & Pope, Henry Craft's Sons, Ham & Carter, Fiske & Coleman and Waldo Brothers, each bidding $1.40 per cask. For furnishing brick for the sewer department in West Roxbury and Dorchester the successful bidders were: Bay State Brick Company at $9.75 per 1000, and Ham & Carter at $9.65 per 1000.

Bids for Laying a Six-inch Water Main.—Engineer Waters, of Minneapolis, Minn., reported, July 30, the following bids for laying a six-inch water main on Stevens avenue, from Twenty-sixth to Twenty-seventh streets: John Gleason & Co., 35 cents per lineal foot; H. B. Wells, St. Paul, 28 cents per lineal foot; Fred Youngsen, 25 cents per lineal foot. The contract was awarded to Fred Youngsen, he being the lowest bidder.

Paving and Water-Pipe Contracts.—Contracts for cedar block paving Avenue road and McGee streets, Toronto, Can., were awarded to Ardagh & Leonard as follows: Avenue road, block paving per square yard 59c.; curbing 16c.; crossing plates $1.90. McGee street, block paving 53c.; curbing 14c.; crossing plates $1.75.

A contract for iron pipe was awarded to the St. Lawrence Foundry Co., at $36 per ton.

Bulkhead Walls and Piers.—The Dock Commissioners have ordered the Engineer in Chief to prepare plans for a line of bulkhead wall extending north 187 feet from North Moore Street, and a new pier at the north end of the bulkhead. The bulkhead will likely cost $350 per running foot. The cost of the pier has not been estimated. They have also reorganized the corps of Dockmasters, rearranged the district boundaries, and appointed James L. Liscomb Superintendent of Docks.

Bids.—Five bids for the erection of a double-story iron and wooden building on new pier A, at the Battery were opened by the Dock Commissioners August 11th. The lowest bid was by Charles C. Brown, and the price was $48,169. To him the contract was awarded. Under its conditions he must complete the shed by Nov. 1st. Then the offices of the Board will be removed to the pier. A part of the pier will be used by the police boats.

The New Medical Museum Building.—Bids were opened at Colonel Casey's office for the erection of a fire proof building for the army medical museum. The following were the bidders and total amounts bid, including those for heating apparatus: D. C. Weeks & Son, New York, $233,637; Frank Baldwin, Washington, $185,490; Bright & Humphrey, Washington, $179,987; August Getz & Co., Washington, $194,000; M. A. McGowan, Washington, $182,540.17; C. A. Schneider & Sons, Washington, $198,405,33; D. J. McCartney & Co., Washington, $200,595; J. F. McDermott, Washington, $191,600.

The Florence Bridge.—About a year ago the St. P., M. & O., in constructing the Florence cut off made an excavation below the road of 75 feet. The county commissioners at once demanded that the railroad build a bridge across this point, with which order the company failed to comply. The case was taken to the Supreme Court of the State the commissioners intending to fight the matter to the bitter end. The county has just received notice, however, that the company has decided to build a bridge, and will do so without further contest. The bridge is to be of 175 foot span, and work will be commenced upon it at once.—*Omaha Bee.*

Work to Begin on the Maryland Ship Canal.—Rumors are afloat that the great ship canal will soon be commenced via Sassafras river. Mr. George Kennedy at Sassafras, asserts that he has sold his right of way for $35,000, $20,000 of which is to be taken in stock of the canal company.

Michael Vincent, of Iowa, has been awarded a contract to grade from Centerville to Yankton, twenty-eight miles for the Northwestern road, eleven and one-fifth cents per cubic yard, with the usual conditions as to haul, etc. The work is to be done in sixty days There is no doubt but Northwestern cars will be running to Yankton by November. Grading will be commenced immediately.

Bids for Iron Work.—The following is an abstract of the bids for iron work of library of State, War and Navy building:

Builders' Iron Foundry, Providence, R. I., $43,250.

Snead & Co. Iron Works, Louisville, Ky., $26,840.

Jackson Architectural Iron Works, New York city, $46,750.

Phœnix Iron Company, Trenton, N. J., $49,000.

Hecla Bronze & Iron Company, Brooklyn, N. Y., $45,-650.

Manly & Cooper Manufacturing Company, Philadelphia, Pa., $54,321.

Contract awarded to Snead & Co.

Contracts for Work upon the Schuylkill River East Side R. R.—The construction contracts for work upon the Schuylkill River East Side Railroad were awarded Aug. 13th, by Colonel H. T. Douglas, the chief engineer of the Baltimore and Ohio R. R. The contracts upon the Baltimore and Philadelphia Road from the city limits nearly to the Schuylkill, were awarded some time ago. In preparing the schedules for the work it was divided up into these seven divisions:

From Cobb's Creek, the western boundary of the city, to the Chester Branch of the Reading Railroad.

The bridge over the Schuylkill River.

The Gray's Ferry section from the east approach to the bridge to Filbert Street.

The Delaware River branch running southward from the bridge, and thence across the "Neck" to the large wharves of the company at Dickinson Street.

The Twenty-fifth Street section, from Filbert Street to Twenty-sixth, involving much deep cutting and under grade work, and the tunnel on Twenty-fifth Street.

The Pennsylvania Avenue section, from Twenty-sixth Street to the Reading tracks.

The work of constructing new bulkheads along the Schuylkill wharves for a distance of 4600 feet.

The contracts which had already been awarded, and which the men are now working upon, were for the grading in West Philadelphia, which had been given to Ryan & McDonald, of New York; the caisson and foundation work for the bridge to Sooy Smith & Son of Chicago, and the masonry work for the bridge piers to Drake & Stratton. The work of grading in West Philadelphia at the Chester Branch and from Cobb's Creek to Sixty-eight Street and the caisson work at the Schuylkill, is well under way. The foundations to be made by Smith & Co. will bring the tiers up to within six feet of low water mark.

The contracts awarded were as follows: Gray's Ferry section, to Ryan & McDonald; Delaware branch, to C. D. Langhorne; Pennsylvania Avenue section, to J. J. Ryan, of Philadelphia; the bulkhead work on the Schuylkill, to Henry Neveling & Co., of Philadelphia. The terms of the contracts are kept private. Work is to be begun within nine days after the bonds are entered into.

Grading.—Over a third of the grading on the Blue Spring, Orange City and Atlantic has been completed.

Paving Bids.—The city engineer of Minneapolis Minn., reported the following bids for paving an alley with cedar blocks:

	Per sq. y'd.
T. J. Canney	$1.28
F. L. Balch	1.30
J. H. Fielding	1.35
James Forestal	1.38
W. E. Forrest	1.48

Philadelphia Sewer Contracts.—In accordance with an advertisement inviting proposals for the construction of twenty-four branch sewers, Councils' Committee on Surveys, Aug. 18th., met to award contracts.

The bidders were numerous, but, as Chief Engineer Smedley announced that the money at his command was not sufficient to pay for the sewers already ordered, no action could be had. A resolution was passed referring the bids to the Chief, with power to provide for the construction of sewers where the requirements of the neighborhood were of an important character. The item of $50,000 has been exhausted, and to build additional sewers a transfer of at least $25,000 will be required by City Councils in September. This will not interfere to a material extent with the sums already appropriated for the construction of any main sewers.

Brick Drain.—Bids were opened at Norwich, Putnam County, Conn., Aug. 15th., for a 24" × 36" brick drain with the following result:

The drain was to have four inch walls; there were to be five manholes and one catch-basin, together consuming 6000 brick, and four lampholes needing 30 feet of 12-inch pipe. Bids per lineal foot include manholes, lampholes and basin, everything complete except rock excavation and ironwork. Rock excavation to be $1.00 per yard. Average cut 8½ feet in sand and gravel, and the length 1233 feet.

The following are the bidders, and price per lineal foot:

Burton & Connihan, Norwich, $2.00; J. H. Austin, Bridgeport, $2.08; A. W. Buck, Danielsonville, $2.25; Gilbert & Hopkins, Danielsonville $2.25; P. P. Wilson, Putnam, $2.41; Sylvester Bissell, Hartford, $2.47; F. S. Streeter, Putnam, $2.50; Patrick Gleason, Putnam, $1.50.

The work was awarded to Burton & Connihan.

The plans were made by C. E. Chandler, of Norwich Conn., and the original estimate was $3,145.

Boston Sewers.—The superintendent of sewers has submitted a statement showing the amount of work done by the sewer department during the years from 1880 to 1884:

Year	New sewers	Catch.
1880	$51,958.43	$21,041.31
1881	98,488.33	30,630.59
1882	155,027.62	30,511.00
1883	154,804.59	26,750.54
1884	240,027.27	31,307.72
Totals	$700,306.24	$140,241.16

Year.	Miscellaneous.	Grand totals.
1880	$52,705.65	$125,705.39
1881	56,100.16	185,219.08
1882	57,656.60	243,195.22
1883	80,751.96	262,507.07
1884	65,207.07	336,542.06
Totals	$312,621.42	$1,153,168.82

Engine House Contract.—Bids for work on the engine house to be erected in Boston, at the corner of Boylston and Hereford street, for cut granite, etc., were as follows:

Cut Granite.—Bunker Hill Granite Company, $534; Robert McGill, $519; J. A. Green, $650; Lewis D. Gumb, $451; D. C. Davis & Son, 664; Artemas Parker, $650; Mannix Brothers, 466; Martin Mullin, $612; P. Blessington & Son, $590; Lyons & Co., $630; E. Ricker & Son $655; High Rock Granite Company, $774; Robert McLaughlin, $653. The contract has not yet been awarded.

Freestone.—F. G. Coughlan & Co., $4,554; R. R. Walsh, $4,390; Willian J. Sullivan, $3,970; Jeremiah Carew, $4,137. The contract was awarded to William J. Sullivan.

Masonry.—N. E. O'Sullivan, $14,381; Joseph M. Keening; $18,500; Seegee & Phaneuf, $18,941; Thomas J. Lyons, $16,921: B. F. Dewing, $16,700; Edward Lynch, $16,500; Donahoe Brothers & Co, $15,528; R. R. Mayers, $16,430; Dady & Flint, $19,412; Gideon Currier, $17,337; Frank Jones & Son, $26,700. The contract was awarded to N. E. O'Sullivan.

Railroads, Bridges and Canals.

Electric Railroad.—The Board of Management of the new American Exposition to be opened this winter at New Orleans has invited bids for an electric railroad in the grounds.

The Sues Canal.—In the course of last year 3284 ships passed through this canal. Of these vessels, 1669 passed from the Mediterranean to the Red Sea, and 1615 from the Red Sea to the Mediterranean.

Prepared for an Advance.—The Milwaukee & St. Paul, R. R. Co., recently purchased twenty-five new locomotives, which they have "white leaded" and stored for future use. This was done because of the belief that there will come soon an advance in the cost of iron and a subsequent advance in the cost of locomotives.

A Florida R. R.—Work is to be commenced immediately on the Tampa (Fla.) Railway and Steamship Company's line.

New Bridge.—The commissioners of Kanawha county, W. Va., have bought the suspension bridge over the Elk river, also the piers of the old Keystone bridge. On them will be erected, also over the Elk, iron bridges, both to be free—something which the county has never before enjoyed.

Defective Surveys.—The Central Pacific Land Office while making up a map of railroad lands in Idaho and Utah, made the discovery that Idaho claimed one boundary line and Utah another, and that a strip of land 2½ miles wide, extending across the northern part of Utah was left, which, by survey, does not belong to either. The surveys used are those filed at Salt Lake City and Boise City.

Northern R. R. of Guatemala.—The direction of its affairs has been changed from the Minister of the Interior into the hands of Mr Nanne, an agent of the Central Railroad of Guatemala, or more definitely, a representative of the company controlling the Central and Southern Pacific, and the lines known as the Morgan and Huntington roads.

That the Northern Railroad shall be built appears to be the determination of the present administration as much as it was of the last.

Fairmount, Morgantown and Pittsburg.—The Fairmount, Morgantown and Pittsburg Railroad, building for the last year from Fairmount, W. Va., to Uniontown, Pa., will be completed and opened as far as Morgantown by the 22d of October, the one hundredth anniversary of the founding of the town. This road follows the Valley of the Monongahela into Morgantown, where it will pass through the valleys tributary to the Monongahela and Cheat. The road will be a short cut from Pittsburg to the interior of West Virginia.

The Kansas, Nebraska and Dakota Railroad—The object of the corporation is to construct and maintain a railroad of standard gauge through certain counties in Kansas and elsewhere. The business of this corporation is to be transacted principally at Fort Scott, Bourbon County, and Topeka. The estimated length of this road is 1,000 miles, and the capital stock is $5,000,000. The following Directors are chosen for the first year: John Francis, J. G. Slonecker, P. G. Noel, C. F. Drake and John Perry, of Fort Scott; John Keller and C. F. Brenneman, of Lancaster, Pa.; Charles E. Pugh, E. G. Postlewaite, Alexander McCaw and H. B. M. Whittman, of Philadelphia.

Lighting the Hoosac Tunnel.—Manager Locke continues to work on the problem of lighting the Hoosac tunnel. He is of the opinion that some sort of an engine will ultimately be used in the tunnel which will not make any smoke, and that when this is done the tunnel can be lighted with electric lights. When this is accomplished it will be become popular for excursionists, who will pass through, stopping at the central shaft where they can climb up the stairway through the galleries to the base of the shaft and take a look to the top of the mountain, over 1,000 feet above. It is proposed to build a platform out into the shaft and have it so arranged that the people who visit this unpoetic spot can take in the stupendous height without being drenched by the constantly falling water.

Proposed Cable R. R's.—At the recent annual meeting of the Minneapolis, Lyedale & Lake Minnetonka Railway Company, the tendered resignation of Colonel McCrory was accepted, and the election resulted in the choice of the following officers: President, S. S. Small. Vice President, C. A. Pillsbury, Treasurer, J. K. Sidle. Secretary, P. S. Mackay. Board of Directors—Messrs. E. H. Steele, C. A. Pillsbury, J. K. Sidle, S. S. Small and P. S. Mackay.

It is reported that the reorganized company will lay a cable road from the union depot to Lake street, within the ensuing year, and possibly change the line from Nicollet to First avenue south.

There is a proposition to build a cable road from Los Angeles to Pasadena, Cal. A new patent is to be used, by which the ordinary tube is done away with. The whole eight miles can be constructed in ninety days.

Work on the B. & O. Extension.—On August 11th Chief Engineer Douglas, of the B. & O. Railroad, received and gave out to the lowest bidders all the work on the on the B. & O Railroad extension through Philadelphia. The lowest bidders met yesterday in the Chief Engineer's office and qualified as to their ability to perform the work required. All who were able so to do signed the contracts. The work of grading between Baltimore and the Schuylkill has been nearly completed. The exceptions are a few miles west of the river and a few miles in Harford county. In the latter place the excavating through a sand hill met with many reverses, and at present the work has stopped here. The entire work, however, will be completed in the early fall. The work at the Schuylkill is going rapidly ahead, and the construction of the caissons for the bridge piers is being rapidly pushed. The one for the draw is nearly ready to be launched. The work is being done with great care, and when it is completed it will be one of the best bridges on the river.

R. R. Extension.—It is reported that the managers of the Mississippi Valley road contemplate running a branch of their road out to Ben Lomond, Miss., opposite Lake Providence.

The Florida Southern Railway Company, are said to have 700 men at work on their line of construction, now pointing toward Punta Gorda. They expect to reach Charlotte Harbor, or Punta Gorda, in about seven months, or by the 1st of March next.

New Zealand Railways.—The tender of Messrs. Miller and Smillie, of Dunedin, has been accepted for the construction of what is known as the Deep Stream section upon the Otago Central Railway. The amount of Messrs. Miller and Simillie's tender was 32,874*l*. The tenders received ranged between that sum an 40,595*l*.

Buffalo, N. Y. & Phila. R. R.—It is said that the Pennsylvania Railroad will be a bidder for the Buffalo division of the Buffalo, New York & Philadelphia Railroad. This piece of road will be of more value to the Penhsylvania than to any other bidder, and there is hardly a question of its getting it.

The Minnesota & Northwestern, has at last found a satisfactory route for the cut-off line from Hayfield southeast. It crosses the Southern Minnesota three miles west of Dexter, and the Iowa & Minnesota division at Taopi, and runs a few miles east of Riceville, Iowa. Officials are now on the line arranging for right of way.

Track Renewal.—Samuel F. Wheeler general manager of the Cairo, Vincennes & Chicago, was granted an order allowing him to issue $1,300,000 worth of receiver's certificates for the purpose of relaying the track with steel rails and equipping the road. This is one of the branches recently dropped off the Wabash system.

Rock Island Extension.—It is stated upon good authority that the Rock Island intends to build into and through Dakota three separate lines. Arrangements are being completed for the construction of one of these this year. The money necessary is already in hand and the route has about been decided upon.—*Globe Democrat.*

New Railroad in Pennsylvania.—A new line under the name of the Philadelphia Midland R. R. is being located between Philadelphia & West Chester, Pa., and is expected to reach Newtown Square by the end of this week, that being about half way along the line. Dr. Agnew is President, and C. Henry Rony, Chief Engineer. Considerable grading and bridging has been done between Philadelphia and Newtown Square by a former company, the Philadelphia and Chester County R. R.

Lake Superior & Southwestern, have filed articles of association with the Secretary of State at Madison, Wis. The object is to construct a line from West Superior to Menominie, via St. Croix Falls. The total distance is 160 miles. It will pass into or through Douglas, Burnett, Polk, St. Croix and Dunn Counties. The capital stock is $4,000,000, divided into $40.000 shares. The directors for the first year are: J. H. Hammond, W. V. Noad and C. L. Catlin, of West Superior, and G. W. Cumming and Joseph Kling, St. Paul.

Side Tracks for the Pennsylvania.—A leading official of the Pennsylvania Railroad Co. stated recently that it was not their intention to wholly abandon the line of the South Pennsylvania Railroad after it came into their possession. They were, he said, badly pressed for track room, and it was only a question of time at the present rate of increase in their business, when their line would be four-tracked to Pittsburg. The South Pennsylvania could be completed for less than it would take to accomplish this, and, therefore, it would be completed in the course of time.—Baltimore *American.*

Yazoo & Memphis Extension.—The Illinois Central Railroad, has purchased from the State of Mississippi, through the Auditor's office, upward of 34,000 acres of land lying in Yazoo, Holmes, Carroll, Leflore and Grenada Counties. The greater portion of these lands are near the proposed route for the extension of the Yazoo and Mississippi Valley Railroad from Yazoo City to Memphis. The purchase is considered conclusive evidence that the extension will be made. It is said that some of the lands are very fertile. Railroad men state that the work of extension will certainly be begun at once and put through rapidly.

Making a Survey.—A party of United States topographers have reached Dalton, Ga., under the direction of Lewis Nell, topographer. They are making a survey upon the meridian of 85 on their way north, with a view to the geological survey of the country which follows the topographical. Other parties throughout the country are following other meridians and preparing maps for the geologists. The party in Dalton, at present, is No. 1, of the Apallachian division. Their work consists in measuring heights, distances, surveying the creeks, rivers, lakes, etc., which come in their course; and a general map is made out by combining the several maps made along each meridian, for geological use.

New R. R.—The construction of the Sanford and Indian River railroad is soon to be commenced.

San Domingo R. R.—A railway is being built from Samana bay to Santiago de los Caballeros, in the island of San Domingo. Of the total 88 miles 40 are now graded, and it is expected to have 65 miles in operation by next spring. The road runs along the Yuna river, up the Valley of La Vega Real, and will be the first on the island.

Pontiac and Pacific Junction Railway.—The Pontiac and Pacific Junction railway will in all probability lose their Dominion subsidy of $272,000 and the municipal grant of $100.000 through failure to construct the necessary number of miles of line by the specified ime. According to the agreement they were to construct 27 miles of railway by the 1st, Sep. 1885. About 20 miles have been built between Aylmer and Quion, but the remaining seven miles is of a very difficult character, and includes the bridging of the Quion river. It is not thought possible to complete this section of the work within the time at the company's disposal.

Philadelphia and West Chester R. R.—The new company organized to complete the Philadelphia and West Chester Railroad is pushing the work as rapidly as possible. A corps of engineers are at work relocating parts of the line and making estimates for the finishing of 10 miles already graded. The contracts for grading will probably be let as soon as this work is done and the company expect to have this line in operation within six months. The road is being built to give shipping facilities to the farmers and dairymen in that strip of territory lying between the Pennsylvania strip of territory and the Central lines and compete for the business between Philadelphia and West Chester.

Gas for Passenger Cars.—A parlor car of the New Haven Road, fitted up with the Foster compressed gas system, is upon exhibition at the Boston and Albany passenger station in this city. Gas was used, but not successfully, upon the New York express trains fifteen years ago. The Foster gas is made from crude petroleum or naptha, and then compressed into storage tanks. The cylinders on the car exhibited are 15 inches in diameter by 10 feet long, and when fully charged will contain 450 cubic feet. The lamps used are entirely new, and regenerative in principle. The products of combustion being used to heat the gas and air to a very high degree before they reach the point of combustion. The result is a clear white and intense light, as steady as an incandescent electric, which it somewhat resembles in appearance. It gives forth no shadow, as there is nothing but a glass globe between the light and the floor. Added to this there is an ingenious arrangement for carrying off the vititated air in the car by the aid of the heat generated in the lamps. This secures better ventilation than has before been attained. It has been adopted by the Mann Boudoir Car Company, who also use the gas for cooking purposes instead of alcohol lamps, which they formerly used.—*Boston Transcript.*

The Rail Requirements of the Future—There are those who look upon railroad construction as about over in this country. When it is mentioned that over 125,000 miles of line are already in use, the average unreflecting mind jumps to the conclusion that the roads already built are quite sufficient for the needs of the country. In many sections the means of transportation by rail are fully up to the requirements, if not in excess of public need. But while this condition exists in the Eastern, Middle, and near Western States, the great Northwest beyond the Mississippi has just begun to develop its need of railway facilities. What has been required and what has been done in the East, and especially in the cluster of Western States lying north of the Ohio and east of the Mississippi, is to be repeated in the territory west of the last named river. The five States—viz., Ohio, Michigan, Indiana, Illinois, and Wisconsin—include a territory of about 250.000 square miles, with about 30,000 miles of railway, or about one mile of line to each 8.3 square miles of territory. In the section including Minnesota, Dakota, Iowa, Nebraska, Wyoming, and Montana, in which a large proportion of the area in soil is similar to and quite as productive as the divisions named east of the Mississippi, are over 600,000 square miles, with about 18,500 miles of railroad, or one mile of line to each 32.8 square miles. This country, especially Dakota and Western Nebraska and Wyoming, is now undergoing the same process of development witnessed in the States east of the Mississippi twenty-five years ago. The needs of the new section for rail facilities are now no less pressing than that of the older section when being first brought into cultivation. To afford the same facilities of transportation to the trans-Mississippi section as are enjoyed in the Ohio group of States will require about seventy thousand miles of railroad, or about fifty thousand miles in addition to what has already been laid. The bulk of this road will be built within the next twenty years. And this is not the only section deficient in rail facilities. The South and the Southwest will require many thousand miles of additional road to meet the requirement incident to the growth and development in progress in these States.—*Boston Transcript.*

New R. R.—Engineer E. G. Bailey, of the James River Valley road, says active operations are to be commenced immediately upon the construction of the road, and that it will be completed to La Moure by Nov. 1st.

Changing Gauge.—The Louisville and Nashville; Nashville, Chattanooga and St. Louis; and East Tennessee, Virginia and Georgia railroads, have at length decided to change the gauge of their tracks before June 1, 1886. The gauge, which at present is 5 feet, will be changed to 4 feet 9 inches. The matter has been discussed for several years, and during the past twelve months or more engines and cars have been bought with this change in view. The Louisville and Nashville Railroad Company have now eleven hoists on their system of roads, and the change will bring great saving to them. To carry the change into effect it will cost the Louisville and Nashville road about $400,000, as nearly as can be computed, or $200 per mile, including changes that must also be made in rolling stock. On the Nashville, Chattanooga and St. Louis line of road these are sixty engines and 2,000 cars which will have to be altered.

Testing a New Brake.—Several officials of the West Shore and Long Island Railroads made a trip to Hackensack Aug 14, to test the system of brakes patented by the American Brake Company, of St. Louis. The patentees travel about in their own cars to exhibit the brake. Seventeen cars were attached to the train. The speed varied from 15 to 33 miles an houre, and tests were made on grades varying from 53 feet to the mile to the level. At the highest speed and grade the train, which was 600 feet long, was stopped in 719 feet Tests were made on the Cornwall grade, which is 80 feet to the mile with, practically the same result. The contrivance is one of independent brakes for each car. They work automatically upon the compression of the drawbar so that when the steam brake is applied to the engine the car brakes act on feeling the pressure. The brake is intended for freight cars only. It is claimed that 3,000 of them are in use on the St. Louis and San Francisco and Wabash Roads.

Railroad Construction.—The following table shows the progress of railroad construction in the United States in detail from the year of its commencement in 1830:

YEAR.	Miles in operation.	Annual increase of mileage.	YEAR.	Miles in operation.	Annual increase of mileage.
1830	23	....	1858	26,968	2,465
1831	95	72	1859	28,789	1,821
1832	229	134	1860	30,635	1,846
1833	380	151	1861	31 286	651
1834	633	253	1862	32,120	834
1835	1,098	465	1863	33,170	1,050
1835	1,273	175	1864	33,908	738
1837	1,497	224	1865	35,085	1.777
1838	1,913	416	1866	36,801	1,716
1839	2 302	389	1867	39,250	2,449
1840	2,818	516	1868	42.229	2,979
1841	3,535	717	1869	46.844	4.615
1842	4,026	491	1870	52,914	6,070
1843	4,185	159	1871	60,293	7,379
1844	4,378	192	1872	66,171	5,878
1845	4,632	256	1873	70,268	4,097
1846	4,930	297	1874	72,385	2,117
1847	5,598	668	1875	74,096	1,711
1848	5,996	398	1876	76,808	2,712
1849	7,365	1,369	1877	79,988	3,280
1850	9,021	1,656	1878	81,717	2,629
1851	10,982	1,961	1879	85,463	4,746
1852	12,908	1,926	1880	93,349	6,875
1853	15,360	2,462	1881	103,145	9,796
1854	16,720	1.360	1882	113,713	11,568
1855	18,374	1,654	1883	121,454	6,748
1856	22,016	3,642	1884	125,379	3,925
1857	24,503	2,487			

The Wisconsin Central Extension.—The announcement that the Wisconsin Central Railway is soon to have an independent line from its present Southern terminus, Schleismgerville, thirty miles north of this city, into Chicago can be no longer disputed. The contract for constructing such a road having been let. While Central officials still decline to deny or admit, this information comes from an authoritative source and there can be no doubt of its truthfulness. Messrs. Harrison & Green, the well-known contracting firm of this city, have been awarded the work, and are to have the road completed by Jan. 1 next. Bids for the contract, it is understood, were opened last Saturday. The successful bidders have gone to work without a day's delay, and are at the present time bending their energies towards carrying out their contract in a satisfactory manner. It is understood that they are securing as many as possible of their old corps of engineers, builders, foremen, etc., and both members of the firm are now absent from the city in the interest of their newly signed contract. The exact location of the new road, which will be the last link of another through line between Chicago and St. Paul and Lake Superior, cannot be definitely determined. The general belief is, however, that the Waukesha survey is to be followed, the company intending to reach Milwaukee by a spur track.

New Bridge.—The contractors on the bridge at Caribou, Me., say they will be ready to throw the bridge open to travel on contract time, Sept. 15th.

Name Making.—When the chief engineer of the Illinois Central railroad was laying out the line, and wanted a mellifluous name for a station, he would shuffle a pack of cards, each inscribed with a letter, until a satisfactory combination suggested itself—as Tolono, Gnarga, Aledo, Diona, Nakoma, and so on.

Index to Periodical Literature.

Bronze.—*The Strength of Bronzes.*—Describes the methods adopted by Prof. Thurston to determine the strength of bronzes, or triple alloys of tin, copper, and zinc, with the results obtained. On a plane equilateral triangle are placed pins to represent each alloy the pins being of a certain height to represent a certain strength; when the surface is covered with these pins a contour map is made of which each line represents alloys of equal strength, the chart also showing the percentage of each metal in the alloys. Illustrated. *Railroad Gazette*, Aug. 7, 1885, p. p. 504, 505.

Crane.—*Ten Ton Hand Crane and Wrecking Car.*—Length of car over all 35 feet 3 inches; width 10 feet; white-oak frames; carried on two four wheeled diamond trucks. The mast is of ⅝ plate steel, and is held in place by castings; the jib is of two 9 inch channel bars, braced. Illustrated. *Railroad Gazette*, July, 31, 1885, p. p. 484, 485.

Dispatch-Boat "Dolphin."—A letter from the Naval Advisory Board to the Secretary of the Navy. Describes in detail the design and construction of the vessel, gives the data used in designing, and enters fully into the question of strength. The speed, I. H. P., machinery, location of guns, interior fittings and other points are considered at length. *Army and Navy Register*, (Supplement.) August 15, 1885.

Electricity.—*Plant for Transmitting Power by Electricity.*—Describes the method of operating a 20 ton foundry crane. The motor is of 4 H. P., and there are two dynamos which can be used separately. The crane, electric-plant, and operations are described and illustrated. The plant has been at work satisfactorily for eight months. *Le Génie Civil*, July 25, 1885, p. 200.

Electric Lighting.—*The Weston Systems in the United States.* A paper on the works and extent of operations of the Weston incandescent system. It gives the extent in New York, and describes the building and plant at the Central station in Stanton Street. There are four Corliss engines, three 24 inches by 42 inches, and one 18 inches by 42 inches; sixty-four dynamos of different power. The Brooklyn Bridge and several North River ferryboats are fitted with this light. A map of the city is given, showing the routes of the wires, and a plan of the central station. *Engineering*, July 24, 1885, pp. 86, 87, 88.

Gun.—*Maxim Automatic Machine Gun.* A paper read before the Inst. of Mech. Engs., April 30, 1885, by the inventor, Mr. H. Maxim. Describes previous forms of machine guns. The recoil is utilized for loading and firing, the cartridges being strung on a belt. The gun is 4 feet 9 inches long over all, is carried on a tripod, and is capable of a number of movements for firing. It is fully described and illustrated in all its parts. *Proc. Inst. Mech. Engs.*, April, 1885, pp. 167 to 197.

Locomotives.—*Locomotives for Secondary Railways of Standard Gauge.* Designed for the Prussian State Railways. Two types of tank engines: First,—four-wheeled, all coupled, cylinders 10.5 inches by 21.5 inches, wheels, 42 inches diameter, wheel base 8 feet 3 inches; boiler, 9 feet 3 inches long, 3 feet 3 inches in diameter. Length over all, 23 feet 6 inches. Weight in working order, 20 tons. Second—six-wheeled, all coupled, cylinders 13.5 inches by 21.5 inches; wheels 42 inches diameter, wheel-base 11 feet 6 inches, boiler 10 feet 3 inches long, 3 feet 6 inches diameter. Length over all, 27 feet 3 inches. Weight in working order, 29 tons. Both types are very similar in construction, having deep plate frames, outside cylinders and valve gear, and spring buffers. Illustrated. *Revue Générale des Chemins de Fer*, June, 1885, pp. 348 to 355.

Passenger Locomotive. Glasgow & South-Western Railway, (Scotland).—Inside cylinders 18¼ inches by 26 inches. Four-wheeled leading truck, wheels 36½ inches diameter; four coupled wheels 73½ inches diameter; wheel base 21 feet 3 inches. Boiler 10 feet 11 inches long, 4 feet 2 inches diameter. Weight in working order 93,000 pounds. Tender has six wheels 46½ inches diameter, wheel base 12 feet, and carries 2,550 gallons water and 7000 pounds coal, Total length of engine and tender over all 49 feet 3½ inches. Fully illustrated. Reproduced from *Engineering. Railroad Gazette*, August 14, 1885, p. p. 513 to 515.

Rails.—*Chemical Composition of some Bad Rails.*—Comparisons between analyses of rails by different authorities, the results are tabulated. It is claimed that the chemical composition is a minor point in wearing quality, and is no guide as to the durability of any rail, but that toughness best indicates the quality, and not hardness or softness. *Railroad Gazette*, July 31, 1885, pp. 486, 487.

Refrigerating Machines.—*On Compressed Air and other Refrigerating Machinery.*—Glances briefly at early attempts and enters into the consideration of the operations. The ether machine, Carré's, and other ammonia machines, and regenerator machines are described, with remarks as to their application to ice making, meat preserving, etc. Notes are given of work done. A lecture delivered by A. C. Kirk, M.I.C.E., March 20, 1884. Published by the Inst. C. E., session 1883-84.

Tides.—*Action of Tide-Waves in Canals and Rivers.*—These waves are formed at the mouths of rivers and canals and often lead to the formation of bars. The paper enters into the action of the waves, the currents, and formation of shoals and bars, with formulæ for the calculation of the speed, etc. Several diagrams are given. *Le Génie Civil*, July 25, 1885, pp. 196 to 199.

Water Gauges.—An exhaustive paper on the different forms of instruments and the methods of calculating from them. Tube and rotary gauges are described, with the process of observations and calculation of averages. Tables and diagrams of experiments and results are given, and the subject is considered in detail. Illustrated. *Annales des Ponts et Chaussées*, June, 1885, pp. 1058 to 1182.

Recent Patents.

A Railway Rail and Joint.—Samuel McCarty, Aurora, Ill. Rails permanently secured to a cross-tie at the centre: the fish-bolts are flat, fitting oblong holes in rail and fish-plate, the object being to compel the expansion and contraction of the rail to take place from the centre to its ends, and so prevent creeping. The rail ends are levelled.

Beton.—Henry A. Hudson, Lyndhurst, N. J. Composed of sand or gravel and cement, solidified by mixing therewith a chemical solution of water, resin, oxide of iron, hydrofluosilicic acid, hydraulic lime, and other materials in certain proportions.

Electric Railway.—Ernest W. Siemens, Berlin, Germany. A series of resistances, a switch, and a rocking frame actuating the contact brushes of the electro motor on the car are used for introducing resistances into, or eliminating them from the electric circuit according as the car is to be stopped, started, or reversed. Pitch wheels are fitted to the motor and car wheel axles, and a pitch chain is used to transmit the motion.

Railroad Block Signalling Apparatus.—Frank N. Kelsey, New Haven, Conn. A post at the end of each block section has an arm which is raised by mechanism worked by passing trains entering the section; the arm being only released by the raising of the arm on the next post, thus always indicating whether the section is clear or not. A gong is also fitted to the post.

Water Elevator.—Henry S. Dagget, Gypsum, Col. Consists of a series of bucket wheels by which the water is raised by successive steps from one to the other to a reservoir, the axles of the series being driven from the main water wheel.

Market Report of Engineering Materials.

New York, August 20, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	1.9c. @	2.2c.
Tee	2.2 @	2.4c.
Beams and channels	3.0c. @	
Tank	2. @	2.1c
Shell	3c. @	3¼c
Steel plates, Tank	2¾c. @	3c.
WROUGHT-IRON PIPE., PITTSBURGH.		
Butt welded, black, Discount	47½	
" galvanized "	37½	
Lap welded black "	65c. @	
" Galvanized "	7½	
Boiler tubes "	60 @	
RAILS.		
Steel (large lots at mill)	27.00 @	27.50
Old rails	16.50 @	17.00
Old rail steel	16.50 @	17.00
R R. spikes	1.8 @	1.9
R R. splice-plates	1.55 @	1.7.
R R. Track Bolts Square Nuts	2.55 @	2.65
Barb-wire fencing, galvanized	4¾c. @	5¾c
" painted	3¾c. @	4¾c.
Corrugated iron		
Nails		
Iron	2.25	
Steel	2.40.	

METALS.

COPPER.		
Lake Superior	11. @	11¼
Other Brands	10¾ @	11¼
LEAD.		
Com. Domestic	4.12½ @	4.15
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	0.05 @	0.05¼

BRICK.

(Cargoes afloat)		
Haverstraw per M.	$5.75 @	6.25
Fishkill		
Up-River	5.25 @	5.75
Jerseys	4.75 @	5.75
Long Island		
" pale	3.00 @	3.50
FRONTS.		
Croton red	13.00 @	14.00
" dark	13.00 @	14.00
" brown	12.00 @	13.00
Philadelphia pressed	24.00 @	25.00
Trenton "	24.00 @	25.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Gibb's English 400 lbs, per bbl	2.75 @	2.90
K. B. & S. "	2.85 @	3.00
J. B. White & Bros., Portland Cement	2.65 @	3.00
do Keene's Superfine,	8.00 @	10.00
do " Coarse,	5.00 @	6.00
Roman	2.75 @	3.50
Largerdorfer German "	2.55 @	2 80
Dyckerhoff, " "	2.90 @	3.25
Stettiner " "	2.60 @	2.65
Hanover " "	2.60 @	2.65
Vorwohler, Lion "	2.90 @	3.25
Alsen, " "	2.55 @	2.60
Fieve "	2.40 @	2.50
Saylor's American	2.15 @	2.40
Windsor } U. S. C. Co.	1.00 @	1.10
Standard } U. S. C. Co.		1.15
Cable's Portland	2.15 @	2.40
ROSENDALE cements	.00 @	1.10

LIME.

Rockland common, per bbl	1.00
" finishing	1.20
State, common	.90
" finishing	1.10
Kingston, ground	0.95
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @	20.0
Choice "	55.00 @	80.
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2½ × 4 to 4 × 6 in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1½, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.10 @	2.25

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" in oil pure "	.05½ @	.05¾
English, B. B. in oil	.06¾ @	.06¾
Red, American	.05½ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11¾
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01¾
Drop black, Amer.	.08 @	.12
" "	.09 @	.11¾
Chrome green	.05 @	.15
Oxide zinc, American	.03½ @	.04
" French	.06¼ @	.06¾

New York City Items.—The Public Works Department will receive bids for grading, paving, and building retaining walls, up to September 1st. The Department of Public Parks will receive bids till September 2nd, for erecting a sea-wall at East River Park: the cost not to exceed $4,500.